ENVIRONMENTAL INFORMATION
FOR THE
TWENTY-FIRST CENTURY

INTERNATIONAL FORUM

INFORMATION ENVIRONNEMENTALE
POUR LE
VINGT ET UNIÈME SIÈCLE

FORUM INTERNATIONAL

PROCEEDINGS
ENVIRONMENTAL INFORMATION FORUM

Montreal, Canada
May 21-24, 1991

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Environmental Information Forum Secretariat
State of Environment Reporting
Environment Canada
Ottawa, Ontario
Canada K1A 0H3

Tel. (819) 953-1437
Fax. (819) 953-3972

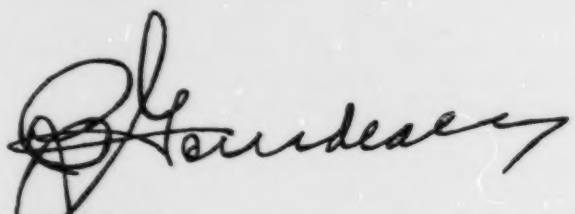
FOREWORD

In 1989, the Group of Seven Summit leaders promised greater co-operation in environmental research and agreed on the importance of environmental information in achieving sustainable development. The Summit leaders recognized the critical role that credible environmental information plays in developing appropriate action on global issues such as climate change, ozone depletion, deforestation and biodiversity. They also acknowledged the need to strengthen the integration of environmental and economic decision-making and directed the Organization for Economic Co-operation and Development to examine how selected environmental indicators could be developed for this purpose. At the subsequent Houston Summit in 1990, Canada reiterated the need to improve the exchange of environmental information internationally, and offered to hold an International Forum to focus work in this important area.

At the Forum, held May 21-24, 1991, in Montreal, Canada's Environment Minister challenged participants to develop a framework for achieving a "second generation" of environmental information. Delegates to the Forum represented 38 countries and 22 international organizations, and their significant contributions are reflected in the quality of the primary Forum product, the *Environmental Information Statement*. The *Statement* provides a set of actions needed to improve environmental information for decision-making today and into the 21st Century.

This document constitutes the formal record of the Forum. It outlines one of the first attempts to address the global and international information needs of decision-makers. I believe that these proceedings will provide a solid foundation for the development of future environmental information policies, programs and procedures.

I would like to express my gratitude to my fellow members of the International Steering Committee, to the Forum Secretariat and to the delegates who came from around the globe to contribute to this important event. It was both an honour and a privilege to act as Chairman of the International Forum on Environmental Information for the Twenty-First Century, and it is my pleasure to present these proceedings.



Jean-Paul Gourdeau
Chairman
International Forum on Environmental Information

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The International Forum on Environmental Information for the Twenty-first Century was convened to provide strategic advice on international and national actions required to give decision-makers improved environmental information. The success of the Forum was the result of the considerable efforts of many people.

The International Steering Committee was chaired by Jean-Paul Gourdeau of Le Groupe SNC. Members included Dan Tunstall of the World Resources Institute, Christian Avérous of the Organization for Economic Co-operation and Development, Antony Marcil of the World Environment Center, Nigel Blackburn of the International Chamber of Commerce, Leslie Whitby of Environment Canada, and Michael Gwynne of the United Nations Environment Programme.

The Steering Committee and Forum were supported by a Secretariat, which was led by Paul Rump and his staff, Annick Le Hénaff and Kevin Brady, with outstanding secretarial services provided by Margarita Merino and Françoise Obissier. The Steering Committee also benefited from the support and advice of Ian Crain, Jim Collinson and Yolaine St-Jacques.

Special thanks go to David Crenna who, under great pressure and severe time constraints, synthesized the workshop reports into a draft *Environmental Information Statement* at the Forum, and completed the *Statement* after the Forum.

As well, thanks go to Forum keynote speakers: Joseph Connor of the International Chamber of Commerce, Jessica Tuchman Mathews of the World Resources Institute, M.S. Kismadi of the Indonesian Ministry for Population and Environment, and Warren H. Lindner of the Centre for Our Common Future. The Forum was opened by the Mayor of Montréal, Jean Doré.

Appreciation goes to the delegates who acted as chairpersons at the Forum, including: Pierre-Marc Johnson, Phillip Ross, Rolland Ramahatra, Graeme Oakley, Ramnik Parekh, Luis Manuel Guerra Garduño, Janos Pasztor, Gertrud Hilf, Janos Vargha, Leslie Whitby, Christian Avérous and Jim Collinson. The chairpersons were supported by the following facilitators: Don Gamble, Pat Delbridge, Jessie Davies, Maureen Payne, Raymond Vles and Jacques Paynter. Special thanks go to the authors, David Pearce, Shirra Freeman, Harvey Croze, Veerle Vandeweerd, Susan Holtz, Shuzo Nishioka and Yuichi Moriguchi, who provided comprehensive and substantive theme papers in advance of the Forum.

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Generous sponsors of the Forum included: the Canadian International Development Agency (CIDA), Bell Canada, Hydro Quebec, Le Groupe SNC, Alcan Aluminum Limited and Environment Canada. Other supporters of the Forum included the following departments of the Government of Canada: External Affairs and International Trade; Energy, Mines and Resources; Statistics Canada; Communications Canada and Industry, Science and Technology.

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INTRODUCTION

Definition of "Environmental Information"

As used in these proceedings, the term "environmental information" refers to data, statistics and other quantitative and qualitative materials that decision-makers require to assess conditions and trends in the environment, to determine and adjust policy directions, and to invest funds. Such information permits decision-makers to analyze cause and effect, to develop strategies for action, to manage natural resources, to prevent and control pollution, and to evaluate progress made towards goals and targets.

Environmental information may appear in "state-of-the-environment" reports and other assessments and studies, statistical compendia and data books, and in policy and program statements by both public- and private-sector organizations. It includes information related to resource pricing and to various industrial and agricultural processes that use and conserve energy and materials, and produce and reduce emissions and effluents.

Information may be presented in many forms and use a wide range of media, among them, reports to government ministers, television news reports, video recordings, international conferences and seminars, group information meetings, public- or private-sector departmental conferences, trade-fair information booths, books, scientific periodicals, and briefs on specific issues.

The production of environmental information entails the ***collection and analysis*** of raw data, and their ***interpretation*** in forms that can be used for decision-making. Because environmental information tends to be problem-oriented and geared to the needs of policy-makers, the data selection process involves the consideration of such key issues as how to frame problems, how to set priorities for data collection, and how to analyze, summarize and assess results.

Scope of the International Forum on Environmental Information

Decision-makers need to consider environmental information as a distinct subject area. In the past, strategies and methods related to the production of environmental data and information have often been regarded as residual or ancillary to other environment and development activities. However, more recently, they have come to the fore because of the need to improve the quality and relevance to decision-makers of all forms of environmental information. In fact, the International Forum on Environmental Information was devoted solely to examining ways of improving environmental information for decision-makers.

The Forum's 119 participants included experts from 38 countries in both the developed and the developing worlds. Also represented were 22 international governmental and non-governmental organizations with an interest in environmental matters.

Forum participants considered the following issues in detail:

- the future ***information needs*** of public- and private-sector policy and investment decision-makers, particularly at international and national levels; and
- how best to ***meet those needs*** — for example, through an expanded and strengthened knowledge base on the links between environment and economy, improved monitoring systems and data-gathering technologies, more comprehensive and focused reporting of environmental information and enhanced institutional arrangements for the production and sharing of information.

Progress in Developing Better Environmental Information

The materials brought to the Forum clearly demonstrated that much has been done over the past two decades to expand the scope and availability of environmental information for decision-making. For example, there have been major successes in detecting and responding to new environmental phenomena, such as ozone depletion. Moreover, global and regional monitoring systems — some of which were first established in the 1950s — have been extended and the technology they use, improved. In such areas as remote-sensing techniques using satellites, new technologies to measure environmental change have been developed and put into regular operation.

In addition, the collection and analysis of environmental statistics have been dramatically expanded in many countries and regions, as confirmed by reports from Argentina, Brazil, European Communities, Finland, Ghana, India, Madagascar, New Zealand, Peru, Poland,

Senegal, Spain and many other nations. Moreover, compendia of environmental data have been developed and published regularly in a variety of countries and regions, most notably by the Organization for Economic Co-operation and Development (OECD) and the United Nations Economic Commission for Europe.

Environmental information reporting, particularly in the form of "state-of-the-environment" reports and indicators, has become more pertinent to the needs of decision-makers, more timely and accessible. The Netherlands, for example, now carries such reporting forward by assessing prospects for the future.

Institutional partnerships have evolved to link efforts in understanding and responding to environmental change taking place in the North, South, East and West. Various organizations — including the World Bank, the United Nations Environment Programme(UNEP), the World Health Organization(WHO), the World Meteorological Organization(WMO), and the Food and Agriculture Organization(FAO), — have set up units and programs dealing specifically with environmental information. There are now many centres of excellence in the analysis and dissemination of environmental information, linked through communications, and bibliographic and referral systems.

A "Second Generation" of Environmental Information

Despite these and other laudable efforts, much remains to be done as part of a "second generation" agenda. As indicated in an OECD statement dated January 1991, the desire for such an agenda is the result of both external and internal factors and considerations, most notably the shift in emphasis from "environmental protection" to "***sustainable development***," which calls for new kinds of data sets and information. As well, there is a growing demand for ***comparable*** data and information, reflecting both the globalization of issues in the areas of environment and development, and the need to measure progress on a range of issues across international frontiers.

The ***remarkable scientific and technological advances*** made in relevant disciplines and fields often lead to situations in which decision-makers are "data-rich but information-poor." Synthesis, explanation and reporting activities need to be expanded to keep pace with the increasing number of data sources and the growing volume of detailed scientific knowledge.

There should be a continuing shift:

- from information on specific elements of the environment to information on "ecosystems," which would cover the full spectrum of environmental relationships within any given region, including the oceans;
- from reacting to environmental problems as they arise to anticipation of them; and
- from a focus on environmental impacts to an emphasis on addressing environmental problems in the context of sustainable economic development.

The Forum Structure

The primary goal of the Forum was to produce the *Environmental Information Statement*. The object of the *Statement* was to provide strategic advice on national and international actions required to give decision-makers improved environmental information. To achieve this goal a number of steps were taken:

First, the following materials were prepared for consideration at the Forum:

- four theme papers, on the subjects of decision-makers' environmental information needs, monitoring and technology, reporting environmental information, and institutional arrangements. As well, a summary document was prepared to help delegates focus on key issues for discussion, and to guide them towards the task of *Statement* preparation at the Forum. Taken together, these papers called for a shift in the environmental information agenda towards the anticipation of future environmental problems; and
- over 65 additional reports and statements from the delegates concerning the status of environmental information for decision-making in their countries or institutions.

The theme papers were distributed to delegates before the Forum and the reports were made available at the opening of the Forum. These materials helped delegates determine the fundamental issues to be addressed and provided various examples of the use of environmental information in decision-making. To help delegates visualize the final Forum product, the summary document also included a suggested framework for the *Environmental Information Statement*.

Throughout the Forum, keynote speakers examined environmental information from a number of perspectives. In welcoming delegates to Montréal, Jean Doré spoke of the importance of environmental information to the resolution of global conflicts. Jean Charest emphasized the importance Canada places on environmental information both domestically and internationally. Joseph Connor provided a synthesis of actions on environmental information by the international business community. Jessica Tuchman Mathews discussed the global state of environmental information and outlined steps for its improvement. M. S. Kismadi gave a personal view of the significance of environmental information to a developing country trying to move toward sustainable development. Warren Lindner articulated a long-term view of the future of environmental information. In acknowledging the completion of the *Environmental Information Statement* Marcel Danis thanked delegates for their diligent work and provided his views on the future role of the *Statement*.

The Forum followed a plenary-workshop format. A series of 12 workshops was organized to discuss four major themes:

Theme 1: The information requirements of policy decision-makers;
Theme 2: Monitoring and technology;
Theme 3: Reporting environmental information; and
Theme 4: Institutional opportunities.

Each workshop session was attended by delegates representing a variety of interests and regions of the world. The purpose of these workshops was to develop directions and areas for action under the four themes. A set of key issues for discussion was developed from the background theme papers and distributed to the delegates in the workshops to provide a common starting point for discussions.

The Forum opened with a plenary session on the first morning, which was followed by discussions on Theme 1. Themes 2, 3, and 4 were considered throughout the second day. Two interim plenaries allowed workshop groups to report their progress. Final workshop reports were received in an evening plenary on the second day. On the third morning, a closing plenary was held to discuss the draft *Environmental Information Statement*, which had been prepared the previous evening.

At the final plenary, delegates were asked to submit detailed oral and written comments on the draft *Statement*. These comments were incorporated into a final version of the *Environmental Information Statement*, which was released on July 16, 1991.

Future Considerations

A fundamental aim of the Forum was to draw attention to the need to focus on environmental information as a policy issue in its own right. Forum organizers and participants believed that the Forum and its products would be useful vehicles for raising the profile of environmental information in the international community. To this end, the *Environmental Information Statement* has been, and will be presented at international fora. Canada submitted the *Statement* to the 1991 Group of Seven Summit and the document will contribute significantly to the development of an UNCED (United Nations Conference on Environment and Development) information strategy.

It is clear that all environmental policy issues have an information component. The Forum is a significant step forward in focusing attention on the significant role of environmental information in decision-making.

ENVIRONMENTAL INFORMATION STATEMENT[1]

Conclusions and Directions

The Challenge for Today's Decision-makers

Public- and private-sector decision-makers at all levels are facing increasingly complex policy and investment choices, many of which require the integration of economic, environmental, social and cultural factors. Scientific, technical and policy information that is timely and accurate, and presented in a comprehensible manner, is essential to the achievement of sound decisions.

Global public concern about the tangible consequences of environmental change (for example, drought and starvation) makes it vital that decisions be soundly based. Not surprisingly, decision-makers feel particularly vulnerable to unexpected developments; it is they who must respond to public expectations of more rapid economic development coupled with enhanced, or at the least, stable environmental quality.

These issues were discussed at the International Forum on Environmental Information, which took place in Montreal, Canada from May 21-24, 1991. Forum participants recognized that all institutions and countries are at the "developmental" stage regarding environmental information, and can learn much from each other. This Statement contains the strategic advice provided by Forum participants on the international and national actions that are required to ensure that decision-makers receive better information.

Information Needs of Decision-makers

Decision-makers need information which:

- is based on the concept of ***sustainable development*** — that is, development that takes into account the needs of future generations in decisions on how and whether to use resources today and apply technologies through policies, investments and development plans;
- is presented within a ***framework based on natural ecosystems*** at national, regional and global levels, as well as on ***human-environment interactions***, stresses and effects occurring within these ecosystems;
- can be assessed and assigned ***priorities*** from the standpoint of human life and health, depletion and productivity of resource stocks, capacity of the environment to support and absorb results of human activity, direct and indirect costs, expert/public opinion, and systematic accounting measures;
- is based on an understanding of the ***causes*** of environmental degradation and of the environmental impacts and cost-effectiveness of ***solutions***, together with an appraisal of the ***uncertainties*** associated with information about both causes and solutions;
- predicts more clearly the ***effects of public and private environmental actions*** on different interests, including different income and age groups, economic sectors and geographic areas; and
- contributes to greater public understanding of environmental issues through more open ***access*** to information and decision-making processes.

How Best to Meet the Information Needs of Decision-makers

Action is required in four major areas in order to improve information for environmental decision-making in the 21st century. It will be necessary to:

- ***broaden and deepen the base of scientific and technical knowledge concerning the fundamental links between the economy and the environment in order to increase understanding of these by:***
  - — collecting, analyzing and putting rapidly into use new data and knowledge on aspects of global environmental change that are currently not well understood, including climate change, biological diversity, land use and degradation, air and water quality, and hazardous wastes;
  - — increasing production and use of research which traces environmental concerns across different sectors, including those of agriculture, industry, housing, transportation, energy and

[1] This version of the Environmental Information Statement includes the Conclusions and Directions and Areas for Action sections only.

land use planning;

— developing and analyzing information on the role of international trade, indebtedness, poverty, population changes and development assistance in environmental degradation and resource depletion; and

— developing new and revised accounting and pricing methods, models and systems which permit environmental costs and benefits to be considered along with other key factors in international and national monetary and fiscal policy, investment, and development program decisions.

- ***extend and improve monitoring systems, and increase the cost-effectiveness and appropriateness of information management technologies by:***

  — building upon long-term monitoring systems and ensuring that there are sufficient collection points in poorer and more remote regions of the world, recognizing that most environmental issues are global and relevant to ***all*** peoples and continents;

  — providing manageable technologies and practical training free of charge, or at cost, to developing and Eastern European countries, and facilitating the local development and maintenance of information bases, as well as a greater understanding of the consequences of industrial development choices currently being made;

  — utilizing more fully and effectively the data produced by existing monitoring and data collection techniques (for example, remote sensing), with priority being accorded to those regions that are most adversely affected by global environmental change;

  — developing expert and telecommunications systems that increase the speed at which the most decision-relevant environmental information can be accessed and used; and

  — increasing both the quality and comparability of the data and information produced by various monitoring systems maintained by governments, research institutes, private firms, non-governmental organizations and universities, by developing common standards and criteria.

- ***widen the accessibility and sharpen the "decision relevance" of environmental reporting by:***

  — supporting organizations that participate in "state-of-the-environment" reporting, environmental audits, indicator and other forms of reporting, and encouraging them to integrate information from ecosystems, elements of the environment and economic sectors;

  — focusing on the creation of new environmental data to support indicators that relate economic stresses to environmental capacities and responses;

  — linking the level of aggregation and coverage of environmental information to different decision-making levels and stages — initiation, implementation and evaluation;

  — recognizing the spatial nature of all environmental data and information and developing improved methods for presenting the products of Geographic Information Systems (GIS);

  — increasing the usefulness and comparability of reporting on legal, regulatory and administrative models and methods associated with sound environmental management; and

  — expanding the use of innovative media for presenting and interpreting environmental information in interesting and meaningful ways — for example, video cassettes, graphics and multi-media presentations.

- ***strengthen and expand partnerships among institutions that currently produce, analyze and disseminate environmental information by:***

  — undertaking a constructive evaluation aimed at increasing the effectiveness and efficiency of existing international institutions (such as UNEP, WHO, WMO, FAO, OECD and EEC) and programmes (such as GEMS, GRID and CORINE) operating in the field of environmental information;

— promoting the long-term development of institutions that are permanent, employ peer review mechanisms, are independent in both outlook and reporting and operate in a flexible and responsive manner;

— increasing, through expanded directories and clearing-house activities, the information available on the operations of various institutions and programmes and the data they house;

— designating a portion of international and national development assistance funds to environmental information and reporting (for example, 10 per cent of the new Global Environmental Fund, managed jointly by the World Bank, UNDP and UNEP); and

— strengthening the legislative mandates and financing of environmental information and statistical services in national, state/provincial and local government organizations.

Areas for Action

Expanding the Knowledge Base to Meet the Needs of Decision-makers

Information Needs for Sustainable Development

Achieving the goal of sustainable development will require the dedication of resources on a long-term basis to the expansion and updating of the scientific and technical knowledge base which underlies all environmental information, and to which all environmental information contributes.

It will be necessary to investigate in detail the relationships and linkages between economic growth and development and the role of natural resources and the environment. This will increase understanding of how to integrate social and economic activities in ecosystem development so that societies can prosper while maintaining resources for future use and appreciation.

The specific areas for action outlined below will help ensure that policy-makers fully consider environmental and natural resource values when they make their decisions. Most require changes in the way economic information is compiled, analyzed and reported.

Areas for Action

- Major economic indicators, such as the GNP, should be modified to reflect more accurately the value of natural resources in generating current and future incomes, and to account for environmental damage. To this end, better information is needed on the basic resource stocks and flows of all countries and the true economic value of these resources. This will require modification of the System of National Accounts which many countries are using to develop measures of production and income. Satellite natural resource and environmental accounts should be developed to expand the accounting ledger.

- Also required are measures that estimate the costs of environmental damage and the benefits of public and private activities aimed at minimizing waste, recycling and reusing resources, controlling pollution, and protecting and conserving resources. These should include measures of environmental productivity, showing how much a given unit of resource is worth in the production of marketable goods and services.

- Renewable resource indicators such as those available for some OECD members could be developed for all countries. These indicators, which show the rates at which resources are being extracted and renewed, include annual growth and harvest of forest resources, annual catch and sustainable yield of regional marine and freshwater fisheries, annual availability and use of water resources, and soil erosion as a percentage of soil formation.

- There is a particular need to develop information that permits the calculation and assessment of both intragenerational and intergenerational inequities associated with environmental use and degradation.

Frameworks for Environmental Information

Without some explanatory framework within which environmental research, monitoring and reporting can be executed, decision-makers will be hampered not only in their understanding of environmental information, but also in their capacity to use it. Potentially useful frameworks that support the concept of sustainable development include: the "pressure-state-response" model; an "environmental-issues" approach; and various cost-benefit

and environmental risk management models. In many cases, these frameworks are mutually supportive. Although important progress has been made towards the development of a widely accepted framework for environmental research, monitoring and reporting (with intensive efforts under way in various countries), a single, all-encompassing framework does not yet exist.

Areas for Action

In developing a framework, the following points must be considered:

- Relationships between environment and economy and those between environment and human activity should be explicitly addressed within an ***ecosystem*** context. An ecosystem perspective has the potential to facilitate reporting efforts at the local, national, regional and global levels.

- To the extent that it is to be used in developing countries and Eastern Europe, any research, monitoring and reporting framework should recognize that an overriding concern in those countries is to satisfy basic ***human needs***.

- Notwithstanding the fact that major data gaps remain to be addressed, both globally and in many countries and regions, the best possible use should be made of ***existing data and information*** before large new data-collection efforts are mounted.

- Different methods for devising frameworks should be tested in ***"real-world" contexts*** by applying them in the form of country case studies.

Assessing the Importance of Environmental Information

According priority to particular aspects of environmental information — particularly when there is so much at stake and global issues are involved — can present experts in the field with major difficulties. Yet policy and investment decision-makers need issues to be priorized so that limited time and scarce resources can be allocated efficiently and effectively.

Areas for Action

- While indicators of environmental damage are relatively well developed in OECD countries, more work is required to understand the tangible effects of environmental problems on the livelihoods of people in many developing countries and in Eastern Europe.

- Major efforts should be devoted to utilizing the health effects of environmental degradation as a basis for assessing both the risks to a given population, and the relative importance of particular issues. Emerging bio-technologies should also be considered as potential health and environmental risks.

- In order to permit decision-makers to systematically review the social and other costs of their decisions, appropriate measures should be developed.

- Expert and public opinion on environmental problems and priorities should be more readily available in countries where this information is not currently collected and analyzed.

- Further to points made above, environment-economy accounting systems of the kind being developed by UNEP, the World Bank, United Nations Statistical Office (UNSO) and OECD, and in France, Norway and other countries, should be considered a tool for analyzing economic and sectoral policies.

- One area of environmental information to which more attention should be devoted is the compilation of information on new industrial processes, including low-input, low-waste, and clean technologies, particularly in the energy, chemicals, military and similar high-stress sectors.

- Consideration should be given to environmental information that enables decision-makers to appreciate and take into account the ***positive qualities of solutions*** they have either attempted or are contemplating, rather than to information that merely quantifies current and potential environmental problems and risks of disaster.

Access to Environmental Information

The primary audience for environmental information consists of policy-makers and corporate or non-governmental organization decision-makers. However, environmental information can also influence decisions ***indirectly***. Members of the general public have the capacity to influence environmental and economic policies.

Areas for Action

- Producers of environmental information should recognize and address the needs of the mass media, which have a substantial indirect influence on governmental, corporate and individual decision-making.

- Greater public access to environmental information should be regarded as an essential element of democratization and empowerment.

- Barriers to expanded sharing and improved access to information should be eliminated to the extent possible, while at the same time respecting and protecting personal privacy and corporate proprietary rights.

- Measures should be taken to protect the freedom of environmental scientists, writers and citizens who use environmental information to criticize the policies and practices of their government.

Improved Monitoring and Technology

Long-term Monitoring Systems

Global environmental monitoring must be accorded a higher priority among nations and international organizations, both governmental and non-governmental.

Areas for Action

- Data collection programs established to monitor the state of the environment and changes in it should increasingly be focused on the needs of policy-makers. This will require policy-makers and data-providers to work together to set priorities for monitoring and collection programs, with ideas contributed by representatives of business, non-governmental organizations and academia.

- Questions to be addressed by these groups should include the following:

  — What are the most pressing environmental problems, and is the existing information sufficient to establish policies and implement programs that respond to these problems?

  — Has an information assessment been carried out?

  — What are the costs involved?

- Countries and international organizations should work together to develop further "core" sets of environment and development data at the global level, which can be refined over time to meet new circumstances. These data should be developed on a sectoral and an ecosystem basis, according to decision-making priorities. The human perspective should be explicitly considered in these core sets, including such factors as socio-economic overlays, performance indicators, prices for commodities, and costs of environmental management.

- Individual nations should be responsible for collecting information about their own environments and natural resources. Better programs should be developed to aggregate data from local and national levels and to co-ordinate data-collection activities at the international and global levels.

- As more and more environmental issues become international and global in nature, new opportunities should be explored for partnerships among non-governmental organizations, business and academia in conducting monitoring and using the results. The linkages between important environmental issues and related interests (in the areas of ozone depletion and global warming, for example), should be stressed in the formation of these partnerships.

- Bearing in mind the costs involved in collecting environmental data and information, monitoring programs should be reviewed for cost-effectiveness in the same way as other public- and private-sector activities. Those engaged in production, analysis and dissemination should be required to demonstrate clearly the benefits of environmental data and information to decision-makers as well as to the public at large. The economic consequences of ***not*** monitoring the environment should also be calculated and made known to decision-makers.

Appropriate Data-Collection Technologies and Training

Information technologies must be developed and applied to serve ***human needs*** and to meet the priorities of decision-makers that emerge from analyzing and interpreting the state of the environment. Training and

education are vital to the successful application of monitoring and information technologies.

Areas for Action

- Especially in developing countries and those of Eastern Europe, appropriate technologies should be developed and offered to encourage community participation in environmental information collection and monitoring. The role of non-governmental organizations in environmental information collection and dissemination should be recognized and strengthened.

- *All* potential data sources should be recognized for their validity and their ability to generate environmental information, including qualitative observations by local residents.

- Training programs should include the following elements: information requirements of decision-makers; environmental concepts and frameworks; use of critical environmental information; orientation to monitoring technologies (including those geared to specific local needs); and analysis, interpretation and reporting of information.

Using Existing Monitoring Systems More Effectively

In the past, the emphasis of environmental monitoring and technology has been on the ***acquisition*** of data to quantify environmental pollution and natural-resource problems. This emphasis must change. For example, only about 5 per cent of LANDSAT data are actually used for analysis. Weatherwatch data could also be more fully utilized.

Areas for Action

- Today and in the future, the focus must increasingly be on the integrated monitoring of ecosystems, the scientific establishment of causal relations, prediction and warning capacities, the analysis of different environmental management options, and other decision-maker needs.

- Important environmental information relating to certain countries may be held in foreign institutions; this should be made fully accessible to the source country.

- The communication of monitoring data can be improved through data aggregation to appropriate levels, better cataloguing of monitoring databases (including those held by the private sector), and greater use of satellite transmission (as in the case of satellite space allocated to African countries).

- The costs of retrieving or gaining access to environmental information derived from monitoring should be reduced by allowing access to satellite imagery at reproduction cost, enriching international data sets with local data, and improving mechanisms for analyzing disparate data. Both Geographic Information Systems (GIS) and expert systems can help to increase access and reduce retrieval costs.

- GIS, in particular, can be used to analyze more rapidly the temporal and spatial facets of environmental conditions. They can be used to show the relationships between natural resources and economic activity, through a succession of overlays (for example, of water quality patterns, fish stocks and mining activity).

Increasing the Quality and Comparability of Data

Closely associated with the more effective use of data derived from monitoring are measures aimed at improving the quality and reliability of data, as well as their comparability across boundaries and ecosystems. The European Community is making progress in this area, and can offer experience and advice to others.

Areas for Action

- Resource classifications, data-collection methods, quality assurance procedures and other technologies should be cost-effective and, where appropriate, harmonized and standardized.

- More specifically, co-operation and innovation in the areas of monitoring and technology should be achieved through interagency work on classification, standardization, "data rescue projects," and, where appropriate, harmonization of methodologies and indicators.

- Information on classifications, standards and criteria for monitoring, technical expertise, training programs, and the like, should be carefully documented and made available through national, regional and international clearing-houses.

Reporting Environmental Information

Developing More Useful Forms of Environmental Reporting

If information is made available to the public on a regular, timely basis, this strengthens trust and co-operation and stimulates efforts towards the achievement of sustainable development. The focus, language and purpose of environmental information reporting, as well as the roles played by producers and users, change significantly as the decision-making process evolves. For example, scientists and resource users or observers may play the main roles in ***problem identification***. At this stage, non-governmental organizations often use environmental information to call attention to a problem and the need for action. As ***alternatives for action*** are formulated in agencies, governments or private corporations, analysts from different professional disciplines use information to determine responsibility for costs, and consequences of action. As ***courses of action*** are determined, senior political and private-sector decision-makers use information to assess how these will affect different interests and constituencies. All participants are involved in ***monitoring and evaluating results*** of action.

Areas for Action

- Environmental information should be communicated to policy decision-makers and to the public at local, national and international levels, using many different mechanisms — including reports, print and electronic media, video cassettes, conferences and workshops — which facilitate the visualization of environmental perspectives and relationships.

- In particular, "state-of-the-environment" reporting methods and processes should be more widely adopted and implemented. "State-of-the-environment" reports should be prepared regularly by all countries, ideally on an annual or biennial basis. These reports can effectively promote ongoing data collection and help to ensure that governments act in a manner consistent with the long-term needs of the population and the environment. National reports being prepared by individual countries for the 1992 United Nations Conference on Environment and Development (UNCED) provide an excellent opportunity for countries to institutionalize "state-of-the-environment" reporting.

- Governments should prepare periodic national strategies and plans for pursuing sustainable development and share these with other countries.

- The scope of environmental impact assessment should be expanded to include entire sectors of the economy, such as transportation. Proposed policy initiatives, including every relevant decision of Cabinets and Legislatures, should receive attention from an environmental perspective.

- For their part, private-sector companies should report on the environment-related effects of their activities. One format for such reporting is the annual environmental performance report presented as an integral part of the corporate annual report.

- As more and more countries become involved in environmental regulation and establish or expand their own environmental ministries and organizations, information-sharing about the legal, managerial and administrative aspects of environmental management will assume more importance. Specific projects should be undertaken to develop and report systematically on experiences with various types of environmental regulations and institutions, focusing in particular on models relevant to the needs of Eastern European and developing countries.

Environmental Indicators

"Environmental indicators" are statistical series that can be used to assess important conditions and trends in the environment. They provide a shorthand method for seeing how well a country is addressing environmental concerns and goals. Indicators can also supplement other environmental management tools, such as environmental impact assessment and cost-benefit analysis. Environmental indicators are more useful to policy-makers in assessing progress when they are integrated with those from other sectors. Recent attempts to improve the quality of indicators have been made by OECD and individual countries such as Canada and the United States.

The construction of many policy-relevant environmental indicators is not feasible because the underlying data do not exist.

Areas for Action

- National governments and international

organizations should develop and publish regular reports of environmental indicators and, to the extent possible, integrate environmental information with socio-economic indicators — for example, energy use, agricultural development, industrial production, health care performance and other aspects of social well-being.

- Indicator research should be undertaken on the state of natural resources and ecosystems and the linkages between biophysical and economic phenomena. Reports of new indicators should show clearly how they were developed, from raw data to final result.

Strengthening Institutional Partnerships

Current Institutions and Programs

There appears to be no need to create major new global institutions to deal with environmental information. To reinforce their past success, national and international institutions associated with environmental information need to be flexible and independent in their operation. Institutions need to strengthen partnerships and co-operation with one another and with interested groups outside the environmental information community. Countries that are currently setting up national institutions for environmental information can learn from the experience of those which have already established such institutions.

Areas for Action

- A constructive evaluation should be undertaken of the current institutional arrangements for the international collection and dissemination of environmental information, with a view to strengthening co-operation and partnerships.

- A full-scale review should be conducted of the role and status of environmental monitoring and reporting in the negotiation and implementation of international treaties and conventions.

- The diversity of institutional needs and arrangements in individual countries should be respected, and efforts made to co-ordinate their contributions through networking and information-sharing.

- Data collection and environmental reporting by institutions should be subject to peer review.

Sharing Information About Activities of Institutions

Decision-makers and researchers in a number of countries experience difficulty in finding the information they need, since both the number of sources and the complexity of environmental information are increasing.

Areas for Action

- Building on existing referral services, widely accessible print and electronic guides that list the environmental information resources available in specific countries and from particular international organizations should be produced and distributed.

- Access to the many international, regional, national and local environmental information centres should be improved through expanded clearing-house operations (via a global electronic network).

- The following functions associated with environmental information should be assigned to appropriate existing regional agencies: co-ordination of environmental information within specific regions; formation or strengthening of networks for sharing environmental information; regional environmental monitoring; and environmental reporting on a regional basis.

Funding for Environmental Information

Environmental information is a resource that requires continued investment, management and planning. Additional financial resources are required to improve environmental monitoring, analysis and communication, particularly in Eastern Europe and developing countries.

Areas for Action

- International donor organizations should increase support aimed at strengthening national-level institutions involved in environmental monitoring, assessment and reporting.

- A given proportion of funds allocated to environmental management on a global basis should be designated for monitoring and assessment activities. For example, the Global Environment Facility, managed by the World Bank, the United Nations Environment Programme (UNEP) and the United Nations Development Programme (UNDP), could designate 10 per cent of its funds to support

data collection and assessment in the areas of biological diversity, climate change, ozone depletion and international waters.

- Bilateral donors of development assistance should be encouraged to work with recipients to create strategies aimed at funding data collection and environmental assessment. Donors already have a record of success in supporting improvements in population censuses and household surveys, and in the collection of agricultural statistics and sanitation data. However, not enough has been done to support the institutional and infrastructural needs of developing and Eastern European countries in monitoring and assessing environmental problems.

- International organizations involved in development assistance should work with developing countries to ensure that environmental information is used in structural adjustment programs aimed at improving people's livelihoods.

Mandates and Resources of National Environmental Information and Statistical Services

Each country must make decisions about the institutions and organizational arrangements that are most appropriate to its own environmental information needs. However, national institutions responsible for environmental information may wish to consider the following ideas.

Areas for Action

- The roles of environmental ministries, statistical services and other ministries responsible for developing environmental information should be strengthened and their activities adequately funded to cover the full range of sustainable development issues.

- At the same time, environmental management and information policies should be incorporated specifically into the mandates and activities of ministries concerned with other sectors, such as energy, agriculture, transportation and industry, as well as ministries responsible for economic planning.

- Environmental information should be made more accessible through a national network of environmental reference centres. To this end, new partnerships should be formed among governments, non-governmental organizations, the private sector and universities to strengthen the management and sharing of environmental information.

OPENING ADDRESS

Jean Doré, Mayor, City of Montreal

A city councillor since 1984, Mr. Doré was elected Mayor of Montreal in the fall of 1986. He has worked as a journalist, acted as press attaché to the former Premier of Quebec (the late René Lévesque) and served as Director General of the *Fédération des associations coopératives d'économie familiale*. He has also been a radio show host, a member of the legal department of the *Confédération des syndicats nationaux*, and an associate in a law firm. Moreover, he has sat on the Board of Directors of the *Commission des droits de l'homme*. Mr. Doré studied political science at McGill University and obtained a law degree at the *Université de Montréal*. He has been a member of the bar since 1978.

Address:

Mr. Chairman, Ladies and Gentlemen, I am very pleased this morning to be able to wish you a most sincere welcome to our fair city for this very important meeting.

I believe that, 100 or 200 years from now, when historians sit down to write the history of the 20th Century, one of the highlights will certainly be the fact that the discovery of space will have literally transformed our perception of this planet. In the 1960s, humankind began to see that, from space, Mother Earth was a small spacecraft that carried millions and millions of people. I think this gave us a greater sense that, for better or worse, we are living in interdependency. We are sharing, in this small craft in the immensity of space, the same air, the same water, the same resources. And I think that this realization hastened us into re-thinking about our planet in a global pattern.

I believe, not only that your role as environmental information specialists and users is fundamental, but also that forums such as this will afford an opportunity to increase public understanding, world-wide, of the major issues our planet is facing, and to accelerate the realization that, if we are to ensure the survival of this planet, our efforts must not only be collective but also united, in the the years ahead and especially during the year preceding the major conference (United Nations Conference on Environment and Development) in Rio de Janeiro.

Our Chairman indicated that, as Mayor of this city and a member of international forums among cities, more and more I see that problems related to the environment are also related to the development of cities and urbanization. By the year 2000, most of the planet's population will be living in cities. That is why, in October of this year, during the summit meeting of great cities of the world that will be held in Montreal, the main theme will be sustainable urban development, in anticipation of, and in relation to, the world conference in Rio de Janeiro in 1992. We are very pleased to welcome you to Montreal and to this Forum, especially because your are dealing with urgent questions for the 21st Century.

I am confident that your efforts will contribute to bringing about considerable improvements in the information that we have on the environment. You are an essential link in the major chain that national governments, cities and individuals are seeking to build to guarantee a more secure future for our planet.

Certainly, the following are at once part of the problems *and* the solutions related to growing environmental concerns. We are preoccupied with, or frightened by, global warming, the greenhouse effect, and the fact that less than 25 per cent of the world's population is now using 75 per cent of the resources that we have to develop. We must re-think the way we develop these resources, in a sustainable development strategy. And we must be sure that this strategy does not mean that we will mortgage the future of our children.

I would like to invite you to set aside a few hours from the very important issues that you will address over the next few days to discover Montreal and to discover our city. By world standards, Montreal is a relatively young city, although in the North American context it is an old city, since in 1992 it will celebrate the 350th anniversary of its foundation. Montreal is the product of both French and British cultures, a cosmopolitan city, the cradle of French civilization in North America. I think you will see that it is a city that is both dynamic and pragmatic, a characteristic it no doubt owes to its Latin beginnings and its northern character.

In my view, Montreal has a unique character. It is a city that blends Europe and America - the only "Ameuropean" city in the world, as I like to say. I invite you, during your brief stay, to visit this city, to discover it.

Montreal is a city that is changing, and changing for the better. We are very concerned with ensuring that what we are doing, in our city administration, about water pollution and air pollution will be inscribed in the global sustainable development strategy, so that "the city" is more and more conceived as an ecosystem that must live in harmony with other ecosystems. I wish you very

fruitful discussions, a most pleasant stay in our fair city,
and a safe trip home. Thank you.

MINISTERIAL ADDRESS

Jean J. Charest, Minister of the Environment, Canada

Mr. Charest was first elected to the Canadian House of Commons in 1984. He has served as Assistant Deputy Speaker of the House of Commons, Minister of State for Youth (the youngest federal cabinet minister in Canadian history), Minister of State for Fitness and Amateur Sport and Deputy Leader of the House of Commons. Mr. Charest received a law degree from the University of Sherbrooke, and was called to the Quebec Bar in 1981. He is a member of the Canadian Bar Association.

Address:

Ladies and gentlemen, I am pleased to welcome you to Montreal, a vibrant and sophisticated metropolis in which Canada takes great pride. I am sure that you, too, will fall under its spell. For some of you, this is a first visit to our country. I know you will find your stay here rewarding and enjoyable.

Canada's natural environment is a rich mosaic of landscapes and ecosystems. We have abundant natural resources -- forests, mineral deposits and waterways -- and a moderate climate. These assets shape our economy and help to define our national identity.

One of the greatest challenges Canadians face is the need to protect our environment while securing both the vitality of our economy and our prosperity in the long term. The concept of sustainable development is, therefore, of crucial importance to us.

In December last year, our government released Canada's *Green Plan* for a healthy environment: a blueprint for putting sustainable development into practice in our country. The *Green Plan* expresses an optimistic point of view; it argues that, in Canada and around the world, we can achieve both high standards of living and high levels of environmental quality. We need only the courage and foresight to take the right decisions about economic activities and to recognize the impact of those activities on the natural world around us.

Achieving sustainable development requires action on various fronts:

- First, we must use science effectively and aggressively as a tool to understand our problems, determine our priorities and formulate solutions.
- Next, we must educate ourselves about environmental problems and what we, as individuals, can do to solve them.
- Finally, we must regulate "smarter" and more efficiently so that good environmental management and good economic policy become one.

We recognize, that to better integrate the economic and environmental factors in decision-making, we must have reliable and pertinent information. That is why Canada places a high priority on improving environmental information, both at home and internationally. And it is why we took the step of stressing that priority in 1989 at the Paris Economic Summit of the Group of Seven (G7) leading industrial nations.

The Summit leaders agreed on the importance of environmental information. In the final communiqué they requested that the Organization for Economic Co-operation and Development (OECD) examine how selected environmental indicators could be developed as part of its effort to integrate economic and environmental factors in decision-making.

In 1990, at the Houston Economic Summit, Prime Minister Mulroney broadened the debate and proposed improving environmental information to make world-wide action as effective as possible. It is at the initiative of the Prime Minister that Canada has organized this International Forum on Environmental Information in Montreal.

Only a short while ago it would have been unthinkable, but today the concepts of *environment*, *health* and *equity* figure largely in our discussions of economic development, trade, energy, transportation and agriculture. In fact, we no longer have any choice in the matter; we must integrate all these factors in setting government policy.

Equally essential is that we rethink our institutions. We must reshape how they operate so that they take into account environmental realities. And we must seek to change the attitudes of decision-makers. In Canada, we have already started to do this. For example, federal policies and programs must be examined for their potential environmental impact before they can be adopted and implemented.

Both private and public sectors regularly gather and analyze *economic* data to detect trends and changes in the economy. On the basis of these data, governments and

companies make the decisions and adjustments that are vital to their economic health.

But economic data are only part of the equation. We also need pertinent information on environment, health and equity to have a proper basis for our political and economic decisions. If we wish to improve our economic decisions -- and by doing so, demonstrate clearly our commitment to sustainable development -- it is essential that we improve the quality, consistency, accuracy and accessibility of environmental information.

We need good information to foresee the harm that some decisions could cause to our environment and natural resources. We also need good information to measure our progress towards achieving sustainable development.

We must act regionally, nationally and globally to improve our environmental information. We must be able to analyze environmental performance through national accounting systems like those we use to analyze economic performance. The purpose of this Forum is to formulate and recommend national and international actions required to improve the quality and availability of the environmental information we wish to provide to decision-makers.

In your discussions, I am sure, you will be able to build on the accomplishments of the past. Over the last 20 years, various initiatives have enabled us to lay the foundations for a global approach to gathering information on the environment. I need only mention the introduction of global monitoring systems, remote-sensing and communications technologies, and state-of-the-environment reporting, as well as the development of environmental indicator systems and natural-resource accounting systems. The second generation of environmental information will build on the first generation.

In particular, we need indicators for measuring the success of our efforts to integrate environmental, health and equity considerations and our decision-making processes. We must also develop a policy framework appropriate to the needs of both developed and developing countries.

The results of your work here and the conclusions that you reach will be of interest to many national and international organizations. As you know, Canada has undertaken to report the conclusions of this Forum at the G7 Summit this coming summer. Prime Minister Mulroney will be spokesperson for the Forum and will communicate the results of your work to the other heads of government at the Summit.

This International Forum has special significance for Canada. Under our *Green Plan*, Canada's government has committed itself to providing accurate, reliable and easy-to-use environmental information to Canadians.

As a step towards fulfilling that commitment, we recently released Canada's first report on a preliminary series of indicators. Also, we are only a few months away from releasing our second national *State of the Environment Report*. And, starting next year, the government will introduce an annual address to Parliament, providing a Policy Statement on the State of the Canadian Environment. This will be the environmental equivalent of our national budget statement.

We must provide Canadians with consistently accurate, understandable information on the state of our environment. Throughout public consultations last year, Canadians identified as a top priority the improvement of environmental information so that they can make informed decisions and judge the performance of others. That is why the *Green Plan* attaches major importance to improving the quality of environmental information in Canada, first, by upgrading our own state-of-the-environment reporting, and second, by committing to working internationally in order to understand better how our performance compares with those of others.

Canadians want to know whether their individual contributions -- recycling, using public transportation, and so on -- are making a difference. Above all, they want a set of criteria with which they can assess the environmental performance of government, much as macro-economic indicators enable people to judge the way that government manages the economy.

This Forum will help Canada to carry out its *Green Plan* commitments. Your advice and recommendations will be invaluable in aiding us to adopt policies and practices that are in line with the principles of sustainable development.

While your work may have special value for Canadians, its principal objective is to provide the world community with input for the decisions that very soon we will have to take. The 1992 United Nations Conference on Environment and Development, to be held in Brazil, is fast approaching. I view your meeting here as a fitting occasion to develop a framework for the second generation of environmental information.

If we are successful in developing such a framework here in Montreal, the 1992 Conference may be the place where we can indeed achieve an international agreement on common information standards. Once we have such

standards, we will be able to apply universally recognized criteria in measuring world progress towards sustainable development. We will also have a starting point for international negotiations on future agreements and treaties.

The challenge facing this Forum is considerable -- no less than the challenge of achieving sustainable development -- and time is short. Your discussions will help all peoples and nations to build a better world in which we respect and protect the environment that sustains us. For your contribution, Canada is grateful.

I thank you and wish you success in your deliberations.

KEYNOTE PRESENTATIONS

Joseph E. Connor, International Chamber of Commerce

Mr. Connor is currently President of the International Chamber of Commerce (ICC). He is Chairman of Price Waterhouse World Firm, a world-wide professional services organization composed of over 40,000 men and women in 100 countries. He was elected to the Policy Board, the governing body of the Firm, in 1973 and became Chairman and Senior Partner in 1978. Prior to his election as ICC President, Mr. Connor was Vice President of the ICC and Chairman of the United States Council for International Business. He serves on the Services Policy Advisory Committee of the Office of the U.S. Trade Representative; the Banking, Monetary and Fiscal Affairs Committee of the U.S. Chamber of Commerce, the Council on Foreign Relations, the Asian-United States Business Council, and the Board of the Council of Americas.

Address: Environmental Information and the Business Community

Chairman, Minister Jean Charest, ladies and gentlemen, at the outset may I express the ICC's appreciation of the Canadian Government's initiative and generosity in co-ordinating this significant and timely event. The ICC were pleased to be invited to join the organizing committee, and it is a personal honour for me to address you now as President of the Chamber.

The Business Community and the Environmental Issue

The ICC is commonly known as the world business organization: 7,000 members, operating in 100 countries, including most leading multinationals. It is no stranger to environmental issues.

My immediate predecessor as ICC President, Peter Wallenberg of Sweden, and his predecessors from Brazil and from the Netherlands -- industrialists all -- made environmental issues a major concern of their ICC presidencies. Unlike my predecessors, I am not an industrialist. I am an accountant -- the Chairman of Price Waterhouse World Firm. I expect that environmental management will feature strongly among our firm's major interests, indeed among the major interests of many sectors of the service community, in coming years. In fact, I am speaking here for the many ICC members who are not manufacturers but have a vested interest in improved environmental management and will make increasing use of relevant data. As well as the service and manufacturing sectors, these include real estate, tourism, raw material extraction, and utilities.

The ICC has adopted three major themes in addressing environmental issues in recent years. Theme 1 is, "The business community must be *part of the solution* to environmental problems." So it has been, first by identifying the issues and then by defining them.

Twenty years ago, at an ICC World Congress, Sir Solly Zuckerman, chief scientific advisor to the British government, first focused the attention of business on environmental matters. At another conference, organized jointly by the ICC with the United Nations Environment Program (UNEP) in Versailles in 1984, another turning point was reached: a reorientation of government/business relations towards co-operation, rather than confrontation, on environmental issues. That conference created a spirit of joint venture between government and business.

Just six weeks ago, at the Second World Industry Conference on Environmental Management (WICEM II) in Rotterdam, 750 ICC participants from 50 countries began to define sustainable development. Essentially, sustainable development means "meeting the needs of the present without compromising the ability of future generations to meet their own needs." This simply defined approach to environmental issues depends on market economics and economic growth to provide the necessary managerial, technical, and financial resources for the resolution of environmental challenges.

An American humourist once wrote, "If I could get my membership fee back, I'd resign from the human race." That is not the attitude business is now assuming on environmental issues. Business is not opting out; it wants to be part of the answer to the environmental needs of the human race.

Theme 2 of the ICC is, "The business community is *acting* on environmental issues." A case in point: in the last few weeks nearly 250 leading companies, national business organizations, and related international institutions have agreed to implement the 16 principals set forth in the ICC Business Charter for Sustainable Development. More will follow. Included among the Canadian signatories are: Alcan, Canadian National, Falconbridge, Noranda, Northern Telecom, and the Royal Bank of Canada.

In brief, the Business Charter lays out principles for business to follow in making environmental management

decisions, to pursue good-faith improvement in environmental performance, and to foster openness and dialogue in communicating progress to the public and to governments. Its words mark a responsible direction. Remember, Jean Paul Sartre once said that words are loaded pistols. Business knows that well in subscribing to the words set forth in the Business Charter for Sustainable Development.

A third theme for business -- one that is the focus of this meeting -- is, "Business must *act as the facilitator* and conduit for environmental information flows."

Environmental questions do, indeed, command more and more attention in the media, and hence, among politicians and policy-makers. In principle, this is natural and desirable. In practice, it is more problematic and can often occur on the basis of partial, superficial, unbalanced and, indeed, alarmist information.

Somebody at this conference will surely use Benjamin Disraeli's famous dictum, so maybe I can be the first: "There are...lies, damned lies, and statistics." Well, vast advances in our knowledge of the world and in statistical method have been made since Disraeli's time, over a century ago. But, the danger of misallocation of environmental and economic resources because of incomplete, untested, or out-of-context data still exists. We must know what we are talking about in preparing the environmental future for subsequent generations.

The attendance and the background documents show how this symposium will make a serious and lasting contribution. Business needs to "put some meat on the bones" of what environmental data are relevant, reliable, and useful.

Let me now note more fully the role of business in environmental communication.

The Business Community and Environmental Communication

I will start by taking issue with the organizers of this conference, who have sought to draw a distinction between producers and users of information. I will argue that the business community is both.

First, the world is better informed on environmental matters, primarily due to technology breakthroughs led by the business community. The sophistication and usage of audiovisual media and telecommunications have expanded enormously in recent decades, and innovation will continue. Print media have also expanded in steady, if less impressive, fashion.

Second, and perhaps more relevant to this meeting, is the enormous development of information technology, again led by the business community, and without which, your symposium would be largely an academic exercise. It is significant, for example, that many computer and telecommunications companies like Northern Telecom, IBM, and AT&T are prominently involved in environmental affairs. Your conference should salute this achievement, and governments should help it on its way. Many economic sectors have benefitted from it enormously.

In principle, the judicious use of information technology can bring about great environmental advantages, notably in resource use. The scope for energy conservation through "intelligent" housing, offices, and transport is, for example, immense. But we should note possible disadvantages. Financial markets and leading stock exchanges, for instance, have become totally dependent on near-instantaneous transmission of data around the world. This is not necessarily a stabilizing factor in managing the world economy. It may also lead to an undesirable stress on "short-termism" when a real move towards sustainable development implies that we need the opposite, i.e. more "long-termism."

Third, the business community is now, and will increasingly become, a major supplier of environmental information. Virtually all human activity has environmental consequences, with the larger industrial facilities and products demanded by modern society having an especially important impact. In recognition of that fact and in response to increased regulatory requirements and public interest, there is now a strong trend now toward environmental performance assessment (or auditing) and public information programs on environmental issues by the business community for its stake-holders. It is realistic to envisage that public pressures will result in the generalization of positive public information programs on environmental issues by companies with industrial facilities and, indeed, by many others.

I want to be very specific on this point of the business community's providing environmental information. The ICC, in the Business Charter for Sustainable Development, sets forth, as one of the 16 principles, voluntary public disclosure, by companies, of environmental activities. We favour the regular publication, by companies, of environmental performance statements (perhaps in annual reports) to inform internal and external audiences in simple terms about the

enterprises' progress. Nigel Blackburn, the ICC's Environment Commission representative here, is working to draft parameters for such statements, based notably on input from this conference. While the information in such statements is expected to be fairly general, it would summarize more detailed data that could also be made available for in-depth studies by public or private research institutions.

For some years the expression, "environmental auditing," has been used rather loosely. Back in 1988 the ICC produced the current international "benchmark" position, which defines the term as a management tool. We maintain that an environmental audit is primarily a tool for measuring achievement in improving environmental management. It is not a vehicle for public information; its value and widespread use would be compromised if it were so regarded.

The "bottom line" is this: the role of business as a supplier of information will become much greater, not least because of competitive pressures. Companies that consider their environmental track records superior to competitors' will boast about it, and will have to provide figures to justify their claims. Their competitors will emulate them -- just as no politician now likes to be "outgreened" by rivals, the same will increasingly apply to business.

Another Facet of Business Communication

Business is already a substantial *user* of environmental information supplied by other parties, by its own trade associations, and through intercompany exchanges. Its use of such information will certainly increase and, we believe, businessmen will become a positive force in pressing for the provision of clear and objective environmental data. Many reasons for this could be put forward, but I will mention just six:

- ***the greater use of market-oriented instruments***

The ICC advocates this as a necessary and effective alternative to traditional on-command and control methods. Such instruments include fiscal measures and incentives, tradable pollution permits, and deposit/refund systems. To work properly, these measures depend on data gathered and interpreted according to sound science.

- ***environmental labelling systems***

This topical concept began in 1978 in Germany, has recently spread to Scandinavia, Canada, and Japan, and is expected to be introduced shortly in the European Community and elsewhere. The effectiveness of such systems depends on criteria arrived at in co-operation with the business community, and on sound product and process information for manufacture and disposal.

- ***international trade and environment considerations***

When and if the Uruguay Round world trade negotiations are completed, the most far-reaching single issue facing GATT and others in the trade policy area will probably be the potential raising of non-tariff barriers to trade for environment-related reasons. This is, indeed, already happening with increasing frequency. Just read the press in the US and Canada on environmental matters affecting the trade negotiations with Mexico. Again there is scope for endless argument about criteria unless clear, objective data are available -- in this case, probably data monitored by some international authority.

- ***prospecting for new natural resources and protecting the atmosphere***

The ICC has never supported the pessimistic views put forward by the Club of Rome some 20 years ago. We believe the natural resources available in the earth's crust will, with sound management including more systematic recycling, last indefinitely. Nevertheless, as the planet becomes more crowded and environmental consciousness rises, we will need to set priorities for, and monitor more carefully, the exploitation of new resources. The protection of the atmosphere will clearly be of priority, too, in view, for example, of the continuing broad debate over climatic change and the very important instance of the ozone layer, on which the historic protocol was signed in this city just four years ago. Undoubtedly, this will require extensive use by business of the ambitious international databases under discussion here.

- ***"green" investment funds***

The "selective use of credit" has been cited as one important lever in the move towards sustainable development. Institutional investment associations, now a huge and growing influence, are increasingly promoting "green investment funds," which are supposed to allocate resources specifically to companies whose activities do not have any adverse consequences and stand to benefit from rising environmental concern. International and national governmental agencies that promote foreign private investment -- for example, the Overseas Private Investment Corporation (OPIC) in the US, the Commonwealth Development Corporation in Britain, and

the Danish International Development Agency (DANIDA) in Denmark -- increasingly need to satisfy environmental critics that the investments they support do not have adverse environmental consequences. The ICC Business Charter has a role here. These funds will need clear, comprehensive, and objective data to support and justify decisions about what constitutes a relatively "environment-friendly" investment.

- ***cost-benefit analysis***

One common misconception holds that, if a particular investment proposal can bring about an environmental improvement, it is necessarily worthwhile. In fact, the resources needed to bring about an environmental improvement are sometimes disproportionate to the benefit achieved. Some of you will be familiar with contentious decisions about, for example, putting high-voltage power lines underground rather than overhead, tunnelling for highways through zones with parks or historic buildings, and so on. An increasing use of rigorous cost-benefit analysis is crucial to this process and will again necessitate sound environmental data.

I have not specifically included one topic in your programme -- namely, the revision of national accounts statistics, or at least, the addition of satellite accounts, which give greater value to environmental considerations. The ICC has, nevertheless, noted this proposal with interest, especially the important pioneering work undertaken by our Rapporteur, David Pearce, and his team in London, and by the World Resources Institute in Washington.

This is clearly a matter of the highest importance for the 21st Century. It will most certainly have implications for many sections of the business community. In due course the ICC and other business organizations will probably formulate their views on how such satellite accounts, and perhaps the ultimate revision of the mainstream accounts, should best be undertaken. This process would have limited value without the much-improved data we are discussing here. I hope and expect that accountancy, which nowadays has its share of "eggheads," will be able to contribute. This, however, is a matter for relatively few specialists, not for the broader uses discussed earlier -- at least as far as business is concerned.

In concluding, I wish to stress that the ICC is the world business organization. A business spokesperson on environmental issues is sometimes perceived as representing one of the industries that are traditionally seen as the major polluters. In the words of a cynic, "A word of exaggeration saves a world of explanation." Well, I am also speaking for our many members who have a vested interest in improved environmental management and who will make increasing use of relevant data. They include sectors such as real estate, tourism, and water supply, and major services such as insurance, banking, law, and accountancy and management consultancy.

The maintenance of our heritage of natural capital will not be easy, bearing in mind the fast-rising population in much of the world, the aspirations for much higher material standards of living by the vast majority of the population outside the Organization for Economic Co-operation and Development (OECD) group, and indeed, by many people within it. Here improved information flows may, arguably, exacerbate the environmental problem, at least in the short and medium term. In past years, many in the former communist countries and the Third World did not desire all the appurtenances of Western lifestyles because they did not know about them. Now they do, thanks to both free information flows and mass communications, especially television. Tomorrow's leaders will have to manage the improvement of living standards outside the OECD group carefully and to ensure that improved environmental information is deployed responsibly as an important asset in the process.

In concluding, it seems that this conference may take a "heavyweight" approach to environmental information. I hope that we do not lose sight of the enlightening, educational, and even enterprising aspects of sound environmental information.

As an example, I mention that since 1989, the ICC, UNEP, and European Commission have jointly sponsored a biennial award for the best video on an environmental theme by a business corporation. The 1991 award winners announced at WICEM II last month were DuPont for a video on ozone layer protection, and Petrofina for a film on plastic recycling. Technical arrangements permitting, I would encourage interested conference delegates to view these productions as examples of this theme's pleasant and accessible side.

It will help us, the "suppliers," to keep in mind that the most important "user" of this information is ultimately the public.

Mr. Chairman, my thanks again for the privilege of addressing this distinguished assembly. The ICC will follow the proceedings with close attention and will certainly communicate the outcome to its membership active in this area.

Jessica Tuchman Mathews, World Resources Institute

Jessica Mathews is Vice President of the World Resources Institute (WRI), a position she has held since the Institute's founding in 1982, and a columnist for *The Washington Post*. The Institute is a policy research centre in Washington D.C., which works on issues of international and global significance concerning the management of natural resources, and the environment. Prior to joining WRI, Ms. Mathews sat on the editorial board of *The Washington Post*, where she covered energy, environment, science, technology, health and other physical resource issues. She was also the former Director of the Office of Global Issues on the staff of the National Security Council in the White House. Ms. Mathews is a member of the Board of the Federation of American Scientists, the Joyce Foundation, and the Population Reference Bureau. She is a member of the board of the Overseas Development Council and serves on the Department of State's Advisory Committee on Oceans, Environment and Science. She is a distinguished Fellow of the Aspen Institute, and a member of the Council on Foreign Relations and the Inter-American Dialogue.

Address: Moving Toward Eco-Development: Developing Environmental Information for Decision-makers

In many ways this meeting represents a "coming of age" of the environmental movement, when government leaders, finance ministers, corporate leaders, representatives of non-governmental organizations, and academics find it, not simply useful, but absolutely necessary to address problems of monitoring, analysis, and reporting.

We should applaud our Canadian hosts, not only for sponsoring this event, but for the remarkable leadership Canada has shown. The Canadian government and corporate and non-governmental organizations have prepared a *Green Plan* for the country; instituted Round Tables on environment and the economy at the national and provincial levels; supported innovative work on resource accounting, environmental indicators, and the study of ecosystem health; and, through initiatives at meetings of the Group of Seven (G7), helped to promote the concepts of sustainable development here and abroad.

While we can take heart that this meeting is occurring, we must not be too optimistic. We know that sound resource use requires a solid information base. And we know that our base is weak. We use this information every day, but we know we are often on shaky ground. We know it is no longer enough to rely on conventional measures of income and wealth to indicate national well-being.

Even while local and regional data remain spotty and unreliable, decision-makers are having to deal with environmental and natural resource issues that are increasingly global. They are also more complex, more uncertain, longer in duration, and -- hardest of all -- often irreversible.

Most important, policy-makers have begun to recognize that environmental quality and the careful management of natural resources are an essential condition for development. The Brundtland Commission has helped to make sustainable development the new goal of economic growth. Environmental problems are now seen as linked to both development and the lack of development, and understood to have immediate consequences for social and economic welfare. We have come to understand that the poor are often forced to degrade local environments, while the rich pursue development patterns that rely heavily on high levels of resource consumption and waste generation. This combination of misguided development and lack of development is leading to global environmental deterioration, increasing the risk of major environmental and ecological catastrophe, and posing a growing threat to international security.

People's understanding of their relationship with nature is one of the most important aspects of a development strategy, and as Michael Colby, Henry Regier and others have documented, it has been shifting rapidly in the last 30 years.

Until the late 1960s, frontier economics dominated in the industrial countries. This approach assumed nature to be a free supply of physical resources to be used for human benefit, and an inexhaustible, free sink for wastes. The economy was disembodied from nature. Most developing countries attempted to copy this approach to economic and environmental management, with the assumption that, if damage to the environment occurred, it could be repaired later, when affordable.

Environmental protection, the second approach, achieved greater influence after the publication of Rachel Carson's *Silent Spring* in 1962. Controlling pollution became a major concern in the industrialized nations, although it was assumed that there would always be tradeoff between

economic growth and ecology. Command-and-control regulatory policies were relied upon to set limits on pollution. Much progress was made, but as economies and, therefore, emissions grew, clean-up became steadily more expensive.

The third approach, resource management, has evolved to incorporate all major types of capital and resources -- biophysical, human, infrastructural, and monetary -- into calculations of national income and wealth and into policies for development planning. Natural resource exhaustion, particularly loss of habitats and species, has become a matter of policy. The interdependence and multiple values of resources are recognized and taken into consideration. Pollution is no longer just an externality, but a cost as real as labour or capital. Climatic and other global systems, and processes that regulate them, become vital resources to be managed.

Eco-development may be the paradigm for the future. It is founded on the belief that our economic systems depend upon, and so must be in harmony with, ecosystem processes and services. There is more often synergy than conflict between environmental management and economic development. We need to move from the polluter-pays principle to "pollution prevention pays", from economizing ecology to ecologizing the economy. In more direct terms, economic development must be designed to reduce the consumption of natural resources per unit of economic output, and to maintain -- and in some cases enhance -- the stock of natural resources, services, and systems.

How does this shift of approaches affect information requirements? As long as nature was treated as a free resource and an open pit for wastes, the key indicator of successful development was production, with productivity measured in terms of output per unit of land, capital, and labour.

As pollution began to cause breakdowns in ecosystem functions and to threaten human health, we developed massive and costly programs to monitor the air, water, land, and biota. Data were collected on emissions and ambient conditions, although often without adequate sampling design and quality assurance. Expensive studies were undertaken to document dose rates and effects on humans and wildlife from exposure to pollution. Productivity was still the key indicator of success, but annual reports and development plans that contained only conventional measures of production were viewed sceptically by decision-makers, who increasingly had to answer to environmental critics.

The resource management approach has expanded our information horizons still further. Policy-makers now need a full accounting of renewable and non-renewable resource stocks and flows, and measures of resource value. Getting the prices right, that is, getting them to reflect accurately the value of resources, is essential. The goals are to modify national income accounts to take natural resource wealth and degradation into consideration, and to require the agricultural, energy, housing, industrial, transport, and other sectors to take environmental values into consideration in their plans and activities.

The move to eco-development will require an even greater fundamental shift in the need for, and use of, information. Industries and communities will need to become fully accountable for all materials used and wastes discharged to the environment, including products disposed of years later. We will need better information on ecosystems (their extent, condition, services, and evolution) if we are to understand and monitor carrying capacity at the local, regional, national and global levels. Even enhancing the stock and flow of natural resources and services in support of development will become the driving goal.

How well are we doing in developing the necessary environmental information to support decision-making under these last two paradigms? The answer is, "Not very well." A report card on global environmental data for decision-makers might look as follows:

- Climate change: D (lack data on average ocean temperature, average atmospheric temperature, stearic sea level changes, pack ice thinning, flow of nitrogen oxides, albedo, etc.);
- Ozone: C (lack measures of ultra-violet radiation, measures of tropospheric ozone);
- Biodiversity: D (lack monitoring of existing species and habitats, measures of ecosystem health, measures of threatened and endangered species, economic values of species, etc.);
- Tropical forests: C (lack periodic measures of tropical forest area and types and rate of deforestation, measures of non-timber forest products);
- Energy: B (lack measures of renewable energy sources, greenhouse gas emission, etc.);
- Human health: B (lack measures, in many developing countries, of mortality associated with

environmental condition, sanitation, human nutrition);

- Land and soils: D (lack measures of land degradation, soil erosion, land use and cover, urbanization);

- Freshwater and oceans: C- (lack measures of groundwater and groundwater pollution, water use, water pollution, sediment flows, coastal ocean quality, chronic sources of pollutants from land-based sources, etc.);

- Air quality: D (lack measures of urban air quality, indoor air quality, transboundary flows and acid deposition, etc.);

- Toxins and hazardous wastes: D (lack measures of amounts generated, transported, treated, disposed, cleaned up, and of contamination); and

- Agriculture: B+ (lack measures of conservation of soils, water, wildlife).

Obviously, a very low C is not acceptable. We can do better, much better. We know what the problems are and the constraints that have to be overcome:

- Many important variables are not monitored or monitored poorly.

- International organizations have limited mandates to compile environmental data, and drastically inadequate budgets.

- Data collection and analysis are often politicized by governments and data are restricted because of fears for national security.

- Donor countries have put few resources into helping developing countries develop the capacity for data collection and analysis.

The list goes on to include lack of training, lack of adequate computer and telecommunication equipment, and the belief that good information will not really make a difference in decision-making.

Let me propose four steps for addressing some of these shortcomings. These are by no means complete solutions, but they are activities that can be undertaken over the next few years without a major shift in values or institutional relationships.

First: **Developing the right approach.** We need to recognize that our present information systems must be overhauled. We are neither collecting, nor disseminating, the information policy-makers need to address national and global resource issues. This must be recognized by both those who produce environmental information and those who use it. Routine allocation of a small percentage of development funds from both public- and private-sector investments will support a large increase in data collection and produce an even larger payoff in sound decision-making.

Also, we must quickly develop environmental indicators – those key statistical series that capture trends in ways directly understood by policy-makers and the public. Such indicators must, of course, be scientifically valid, but they must also be condensed enough and transparent enough to provide a means of taking the pulse of global environmental health and seeing at a glance whether it is improving or declining. Economic planning would be adrift without Gross National Product (GNP), unemployment rates and the like, and social planning would be impossible without demographic indicators (fertility rates, infant mortality, literacy, life expectancy). Yet, this is precisely where environmental policy-making stands today. We should not insist upon academic perfection in designing such indicators. GNP and many of the other key economic indicators are deeply flawed instruments, but they are, none the less, enormously valuable.

We also need to look for new partnerships that include the private sector, government, and independent organizations. Much of the data on wildlife habitat in the United States, for example, are now compiled by independent Organizations such as The Nature Conservancy and The Wilderness Society. Through various co-operative agreements, this information is being made available to governments and used for planning nature reserves, wildlife sanctuaries, wildlife easements and the like. Governments should not be expected to do everything.

Second: **Improving access to information resources.** The Food and Agriculture Organization (FAO) *Production Yearbook*, the prime world report on agriculture, costs U.S. $75; the United Nations *1988 Demographic Yearbook*, sells for $110; a computer tape of one LANDSAT Thematic Mapper image (185 square kilometres at 30 metres resolution) containing data that resource planners can use to optimize their selection of potential cropland, costs $3,200. Clearly, the basic information on the condition of the world's environment and natural resources is out of reach of most analysts, in government and elsewhere.

How are the developing countries to develop strategies for wise resource management if they do not have access to the data? How will we ever be able to build consensus on treaties that entail significant changes in national behaviour, unless citizens of all countries can see the facts on which they are based?

In my own organization, we have tried to breach this gap by compiling the *World Resources Report* in co-operation with the United Nations Environment Programme and the United Nations Development Programme. It is intended to meet the critical need for accessible, accurate information. Although more than 40,000 copies of the 1990-91 edition have been sold or distributed in four languages, we know we are just beginning to reach the decision-makers who need this kind of information. In this past year we have added a *Teachers' Guide to World Resources* and a computer diskette of the World Resource Data Tables.

Third: **Funding global environmental monitoring and data programs in developing countries.** The information needs of decision-makers in developing countries, are not being met. Two things must be done. First, the donor community needs to help developing countries build up their environmental information networks, facilities, and programs. The UNEP helps co-ordinate the collection of global environmental information through the Global Environmental Monitoring System, but it does not have the means to help developing countries improve their own data collection.

It is time the donors directly addressed this gap in their grants and lending operations. There are precedents for this strategy. The U.S. Agency for International Development once poured millions of dollars into improving population censuses in Africa. Similar donor-assisted programs have helped in compiling data on childhood diseases, agricultural production, and macroeconomic statistics.

Specifically, the Development Assistance Committee of the Organization for Economic Co-operation and Development should be called upon to assess the environmental information needs of developing countries, develop an environmental data and monitoring strategy, and establish a joint fund for the support of environmental monitoring and assessment activities and institution-strengthening in less developed countries. Second, the World Bank's Global Environment Fund, which will soon begin allocating $1.2 billion (thousand millions) in funds to developing countries for projects that directly benefit the global commons -- climate change, biodiversity, ozone, and water pollution in international waters -- should be encouraged to earmark money for monitoring and data collection. A data tithe of 10 per cent would help developing countries improve their statistical operations and generate information that is of immediate and direct use to the world community. This is a bargain that would benefit North and South equally.

Fourth: **Improving data on tropical forests.** Finally, let me make a special plea for tropical forests. Knowledge of the extent and health of the world's tropical forests is limited, even dismally so. Yet, accurate, timely data are necessary to inform policies that affect conservation of biodiversity; emissions of carbon dioxide and methane; maintenance of existing patterns of rainfall on the local, continental, and global scale; sustainable harvesting of wood and other forest products -- and to influence the material well-being of millions of people.

The FAO, which is charged with maintaining information on the world's forests, has devoted most of its attention to the production and trade of wood products. Its first systematic estimate of the world's tropical forests was completed in 1983 for the 1980 reference year. That assessment assumed that the rate of deforestation of closed tropical forests in the early 1980s would remain relatively unchanged from that estimated for the late 1970s: 11 million hectares a year. This assumption and the lack of any systematic updating of information for the late 1980s led to distorted policies and missed opportunities for conserving this resource. Preliminary estimates from the 1990 assessment were released last year and showed that the actual rate of deforestation during the 1980s was about 17 million hectares a year.

Decadal assessments are inadequate. There should be a continuing assessment that will generate provincial, national, and global estimates of the extent and condition of forest of various types, the degree of fragmentation, the amount and type of regeneration and reforestation, the extent of logging, and the health of major forest ecosystems. The FAO has proposed converting the 1990 assessment, on which it is now working, into a Global Continuous Forest Resources Monitoring (GCFRM) system. There is, however, no funding for such a program, and without a new initiative, the dedicated FAO team will be disbanded in early 1992.

The UN Conference on Environment and Development should take up the challenge of institutionalizing forest monitoring by supporting the funding of the GCFRM. To the extent that FAO funding cannot meet the challenge, other organizations should be given the task of collecting and analyzing these data. Regional data and

analysis centres with such mandates should be established in Latin America, Africa and Asia. We cannot just wait for another 10 years and then find we have misallocated natural wealth and wasted an opportunity to protect these threatened ecosystems.

We know that better information -- more accurate, more timely, and more credible information -- does not guarantee better decisions. But we also know that, without it, we are feeling our way in the dark, relying on guesswork and luck. The availability of accurate information will have much to do with whether lasting development will occur and who will benefit from it.

There are times when the odds against success seem very great; familiar ways of doing things and ignorance about their long-term effects seem to have so much greater momentum than the forces of change. We must, however, remember John Maynard Keynes' wise insight. "I am sure," he wrote, "that the power of vested interests is vastly exaggerated compared with the gradual encroachment of ideas." The idea of sustainable development -- that is, of wise resource management as the essential underpinning of long-term growth -- is inseparable from timely, accurate, focused information. With it, and only with it, much that we hope for humankind will become possible.

M.S. Kismadi, State Ministry for Population and Environment, Indonesia

Mr. Kismadi is the Special Assistant for Foreign Relations at the Ministry. He worked very closely with the World Commission on Environment and Development, is Indonesia's representative to the Association of South-East Asian Nations (ASEAN) Senior Officials on the Environment and has attended and led his country's delegation to the United Nations Environment Programme (UNEP) Governing Council over the past decade. Mr. Kismadi graduated in Journalism, and at one time was a Professor of Journalism and a founding editor of *Asia Magazine*. Mr. Kismadi is currently one of the foremost thinkers on environment and development issues.

Address: Enriching Information

I cannot begin to tell you how pleased and how greatly privileged I feel appearing here. Standing before you, I feel that I represent -- or ought to -- something that is otherwise not represented at tonight's meeting.

First, I represent a different way of life, a different historical background and therefore, perhaps, a different world view and a different view of history -- also, perhaps, a different view of information and communication. I am bringing up the issue of information because it will be the theme of the discussions that will commence tomorrow.

More specifically, I believe, those discussions will deal with a country's information needs in its pursuit of sustainable development. Obviously those needs will be shaped by that country's views concerning the issues of development and environment and their interrelationships. But those needs may also be shaped by the ways a country looks at the issue of information itself.

As you know, Indonesia is committed to implementing sustainable development that stands for the proper integration of development and environment. This means that, although to us and to developing countries in general, the pursuit of development is our foremost imperative, environmental factors must now be made an integral part of our development efforts. Those environmental factors and considerations should not be treated as a mere appendix to development efforts.

In simplified terms, we see development as efforts to assure that today will be better than yesterday and that tomorrow will be better than today. The idea of continuity between today and tomorrow is also central to the general definition of sustainable development as development that will meet the needs and aspirations of today's and tomorrow's generations.

Both continuity and sustainability imply the acceptance of constraints -- primarily, but not entirely, environmental constraints -- upon our development efforts. That there is a relationship between environment and development has always been recognized, but it must now be consciously heeded. We must now reassess that relationship in order to redefine development efforts.

Essentially, this means that those efforts must now be kept within certain bounds that are determined by the desired quality of the environment to be maintained and by the continued availability of the natural resources necessary to feed and energize development.

In other words, the implementation of sustainable development has to be directed towards:

- Achieving a minimum rate of economic growth and development. This is required to meet the growing needs of a growing population and to allow the

pursuit of other development goals, including environmental goals; and

- abiding by the constraints imposed upon development by the environment so that development efforts and natural resource utilization do not exceed what may be termed an environmental ceiling. Exceeding that ceiling would endanger the quality of the environment, ecosystemic functions and the sustainability of the stock of natural resources. Such an environmental ceiling, however, is not fixed or immovable. Through conscious efforts in resource management and environmental management, such a ceiling can be moved upwards.

Therefore, our efforts are to be directed towards constant monitoring of the state of the environment and of natural resources. Also, we must constantly endeavour to raise the environmental ceiling, and in that way broaden the parameters in which development is to take place. Such environmental efforts include increasing resource-use efficiency, recycling, and the development of natural resource substitutes in addition to the general objectives of environmental management. These include:

- managing, maintaining, improving and, where necessary, rehabilitating the quality of the environment;
- managing, controlling and alleviating environmental impacts; and
- managing, maintaining, improving and, where possible, renewing the stock and the diversity of natural resources.

Required above all, is that all development decisions be properly informed by as precise a knowledge as possible of the state of the environment and the state of natural resources. To meet this requirement, it is essential that we develop and implement a resource accounting system that, ideally, will lead to the improvement and the reformulation of the present System of National Accounts.

I believe that this brief sketch is adequate to give you an idea of the kind of information that we need. We will have to generate a good portion of this information ourselves in Indonesia, once needed data are properly identified and acquired. All our information should be augmented by information available or generated abroad.

We would also benefit from information and from assistance in identifying our data needs, in strengthening our available database and in developing new economic concepts and tools of analysis for the implementation of sustainable development. I believe that further details concerning these aspects will be dealt with in the sessions of the forthcoming meeting.

At this point, I would like to share with you some observations on what should be the underpinnings of an information system involving international co-operation. It is for this purpose that I have earlier referred to the cultural differences which may exist between us.

I begin with the truism that information is knowledge. Therefore, as does knowledge, information contains two different value aspects. The first aspect pertains to the instrumental value of information, namely, that which can serve as an instrument in solving a specific problem at hand. I believe that the focus of the coming meetings will be on this aspect of information.

The second value aspect of information is more difficult to define. It is that acquiring information would broaden our horizons in practical and normative terms. It would, in general, improve our problem-recognition and problem-solving capabilities as it informed us about what is normatively appropriate and what is not.

In other words, it is the value aspect that pertains to our ability to discern cultural options and to make value judgements. As such, information also serves to broaden and enrich our views as individuals and as members of our respective societies, which, in turn, increases our abilities to contribute to the processes of value formation that go on endlessly in all societies. In such a context, any transfer of knowledge, of information, of technology, always involves a transfer of culture as well.

But why should we concern ourselves with that cultural aspect of information? Could we not simply focus our efforts upon the instrumental aspects as these would be required for us to deal with our many and practical problems?

We could do so to the extent that such problems are self-standing and to the extent that our policies in dealing with such problems do not need to be institutionalized and sustained over time. To do so would also be wasting the positive potential contained in the exchange of information.

As you know, as a developing country Indonesia is entering a very important stage in its development. It is a

stage of accelerated growth in which we must heed the various national development imperatives as well as national and global environmental imperatives. This requires new problem-solving capabilities, and the adoption and institutionalisation of new policies.

These conditions have been achieved, not only in Indonesia, but also in many other developing countries. At the same time, we are faced with a tremendous increase of global information flow, a development that has helped bring about the phenomenon often referred to as global interdependence.

Incidentally, the phrase, "global interdependence," often evokes an image of symmetry in the relations between the globe's nations. The present reality, however, is that those relations are not symmetrical and that there is an imbalance in favour of the advanced countries. This also applies to information as the developing countries are lagging far behind in their ability both to generate and to absorb information, to independently verify incoming information, and even to sift the tremendous deluge of information -- sought or unsought -- upon them.

We in the developing countries must, therefore, exercise care in availing ourselves of information from abroad. First, we must ensure our continued openness to incoming information and promote its inflow. At the same time we must carefully weigh, not only the validity, but also the applicability and the utility of, such information within our institutional, social and cultural contexts.

It is obvious to most of us that information, to be applicable, should fit into an institutional setting. But it is sometimes less obvious that the utility of information depends on positive cultural evaluation, because utility, or instrumental value, seems to be self-evident.

Especially when information is to become the base of policy, it must be made to fit into the cultural matrix of the recipient country. Information's utility can also be impaired by social conditions. For example, the rigid hierarchism and the pre-eminence of vertical over lateral relations in many developing countries may hamper the internal dissemination of information, and thus, lessen its utility.

Many other examples can be cited to show the care that must be exercised by information-seeking, developing countries. But what about the information-dispensing countries? Would it not be sufficient for them just to pass on the requested information, leaving its utilization to the requesting country? Such a procedure would mean foregoing any feedback, and this would mean foregoing further validation of the information provided. It would also mean foregoing the enrichment of the intrinsic value of such information, an enrichment for all of us that is the result of the continuous exchange of information.

Therefore, it is important to ensure, as far as we can, that the information we provide is appropriate, important and meaningful to the recipient and that it will initiate or sustain a continuous exchange. We must, therefore, concern ourselves with the social and cultural setting of the countries with which we exchange information. In essence this means that we should try to define such a social and cultural setting; that we should try to define the cultures of others for ourselves.

As we define other cultures, we also redefine our own cultures. This lies at the core of cultural change and it is in this process that the intrinsic value of information is of such vital importance to each of us in our respective national and cultural settings. But more than that, the continuous process of defining and redefining cultures -- our own and those of others -- will help in defining points of reference common to all of us, points of reference that are needed for better communication between nations. It is essential that such common reference points be developed if the current processes of globalisation are to yield benefits that all can share equitably.

All of this, I am sure, sounds familiar and even trite. But it is true that the processes of information-sharing, of redefining cultures and of developing global points of reference are lagging behind the rate of actual change that is occurring in the world today. This has affected the quality of information exchanged.

As a result, we may have acted erroneously in our relations with other countries, or suddenly been faced with new realities that are difficult or impossible for us to comprehend. Such new realities include the emergence of newly independent, developing countries some decades ago; and more recently, the rise of a renewed nationalistic fervour, of ethnic assertiveness and of religious militancy. Often we feel at a loss to evaluate information on events in Iran and in the Middle East in general, in Eastern Europe after the fall of the Berlin Wall, and so on.

Information confusion -- in different contexts -- is felt by all countries, not just by the countries of the West. Indians and Russians alike are baffled by the resurgence of ethnic unrest in their countries; many Moslems throughout the world have ambivalent perceptions of the Gulf Crisis and its aftermath; and people from developing and advanced countries have yet to establish a common

view on the appropriate balance between development and environment. Incidentally, in this last context, many developing countries are somewhat worried that the advanced countries are now making the environmental tail wag the development dog.

All of this shows a shortage of common reference points in processing and evaluating information. All of this may also mean that we have incorrectly or inadequately defined other cultures, or that we have incorrectly defined ourselves to others.

There is, therefore, a need for conscious comparison of different perceptions of information. In this context we should recognize and accept that most information now available in the world has been generated and organized along lines of perception associated with Western civilization. But, the fact that those perceptions are shared by the majority, including people from other civilizations, will not undo the persistence of other perceptions. Nor will it let us easily anticipate the ways people react to shared information.

As I mentioned earlier, consciously comparing different perceptions will enrich the information we possess and exchange, and enrich our lives and cultures. It will increase our ability to better comprehend events and developments that the future may bring us. Finally, it will keep us from the ethnocentric, cultural complacency that would proclaim the death of history because there would no longer be any challenges to our perceptions of history.

As we enter the 21st Century, we should be aware that it will bring additional millions upon millions of people who will, in a sense, awaken to history as development and access to information bring emancipation to them. To safeguard our common future, we must start today, learning to shape a shared vision of history and of the future as we endeavour to fulfil our existence and pursue our respective goals.

Warren H. Lindner, Centre for Our Common Future

Mr. Lindner is currently Executive Director of the Centre for Our Common Future in Geneva, Switzerland. The Centre was established to act as a focal point for follow-up activities on the World Commission on Environment and Development report *Our Common Future*. Mr. Lindner is an attorney who received his law degree from Duke University in North Carolina. He was Secretary to the World Commission on Environment and Development and Deputy Director of the World Wildlife Fund. He is also Vice President of Gulf International Corporation, and a member of the Board of Trustees and Honourary Treasurer of the North-South Round Table.

Address: Uniting for the Future

When I was approached to give these remarks, I was told to provide a thought-provoking long-term, global view for environmental information through to the middle of the next century. This task is daunting, in 15 to 20 minutes. The provocative part is fairly easy; the long-term view into the middle of the next century, however, is the real challenge, since even modellers and sophisticated data users have trouble with predictions of that nature.

As I am sure you expect, my starting point is the Brundtland report and its call for sustainable development -- the conceptual framework in which all our discussions here have been taking place. I do not want to join the debate about what it does and does not mean. I am prepared to go along with the definition contained in the report and David Pearce's operational extension of that definition. I want only to underscore that that term, however defined, has, not only ecological or environmental and economic dimensions, but also -- and in my view, most importantly -- social dimensions. And those social dimensions of sustainable development cannot be overlooked or ignored.

But let me turn for a minute to the Brundtland report. As you are aware, it is known for many things it said or did not say, as the case may be. One thing it certainly did was to make the most convincing case to date for the relevance of ecological, economic and social linkage in humankind's struggle for global management. It demonstrated most effectively what the effects of ever-increasing human numbers and ever-continuing human activities have been and continue to be on the natural systems of this planet and on the living and economic conditions of the peoples who inhabit it.

I will not repeat the litany of statistics that I am sure you are all familiar with on poverty, economic imbalances, exponential growth in economies, pollution and threats to life support systems. Suffice it to say that, by any definition you use -- Brundtland's, Pearce's, Daly's -- or even if you do not use a definition but apply common sense, the globe is clearly not progressing sustainably. As we now conduct our affairs, we are certainly not preserving options for future generations, much less

providing for hundreds of millions of people who are with us today. We are, thereby, sowing even more seeds of unsustainability as the poverty-environment interlinkage sets in.

This fact leads me to the first point I want to make about the world of tomorrow and the changing information needs it implies. I am convinced, as are many others, that, to a great extent, the situation we find ourselves in is the result of the global management approach we use (or, as I would argue, that we do not have). We run the world as we run universities: in separate departments. It is now clear that interlinkage and the positive and negative feedback mechanisms of the decisions and activities of individual nation states have become greater over the past two generations -- so great, in fact, that their aggregate impact is posing real threats to global security and creating issues we have never before, as a global community, had to face.

Indeed, one of the new realities of our march into the next century is the fact that, today, no nation, poor or rich, powerful or weak, big or small, has unfettered freedom to operate its own economy or decide its own destiny. And this constraint on our freedom of individual choice will increase -- not decrease -- as we move through the next 60 years.

Yet, in the face of this reality, we continue to define global management as the aggregate of facts of 160 separate, self-interested, decision-making processes. This is not appropriate in the world today and certainly will not be appropriate in the world of tomorrow, where the combined effects of even more people and their activities will narrow our global options and necessarily broaden the parameters of our national self-interests.

Another of the important characteristics of our transition to the next century will be the ever-increasing importance and operativeness of global decision-making processes and the ever-decreasing relevance of sovereignty as the underpinning of national self-interest. In this regard, I quote from the report of the Stockholm Initiative on Global Security and Governance, which was issued last month by a group of 36 eminent personalities, including the prime ministers of Sweden and Norway, and President Havel:

"Global security will not be achieved unless international co-operation is extended to deal with the threats that stem from failure in development, environmental degradation and lack of progress towards democracy. The injustices that prevail throughout the world are a constant threat to the security of nations and people. Increasing economic and ecological interdependencies have not been met by a corresponding strengthening of global co-operation and governance."

"After a decade, the greater part of which was characterized by arrogance and selfishness, we need to restore global morality. We need the vision of being one global neighborhood. We need a new world order, based on justice and peace, democracy and development, human rights and international solidarity, without which humankind might not survive the next century."

Such a transition, from a bilateral to a multilateral world, will clearly have significant and, I think, self-evident ramifications for information gathering, analysis, use and ownership.

Let me now turn to a second point. Clearly, we will not reach global sustainability before the middle of the next century or later if we do not soon find solutions to the gross international economic and development inequities in this world.

In a world where the ideological battle of environment and development is not over but must be outrun, information will play a narrowing or widening role in the debate between the developing and developed countries. The mere fact that the United Nations Conference on Environment is not a Conference on Sustainable Development obviates the fact that the political will to address some of the most fundamental obstacles to sustainable development does not yet exist.

When the following conditions remain:

- the developed, industrialized countries, from ignorance or neglect, have, through the use of inappropriate production processes, pushed the earth's natural support systems to their limits, thereby restricting development potentials for the rest of the world, and still refuse to accept responsibility for their actions and the obligation to compensate for the damage they have done;

- lack of development is still merely the focus of television marathons;

- industry congratulates itself for having discovered (or having been made to discover by market forces) that consumers can be green, and still is slow to face its multinational responsibility for a share of the development crisis;

- resolution of the debt crisis that faces much of the developing world is shadowed by attention and financial assistance to the newly emerging countries of Eastern Europe;

- requiring integration of environmental considerations into development plans by bilateral and multilateral financial institutions is seen by the recipients as a new form of eco-conditionality;

- new and additional resources, and transfer of the technology necessary to permit establishment of alternative development patterns for developing countries are issues that may be "too hot to handle" in Brazil in 1992;

-- then, I think, we have not resolved the debate.

But here again, data and information that clearly demonstrate the economic and development links between underdevelopment and overdevelopment and the positive and negative effects they have on the potential for continued, sustainable development, both in the North and in the South, can play a decisive role in putting the debate on logical grounds, rather than ideological or moralistic ones.

I used to believe that basic human decency would motivate people to change -- that basic concern about gross inequities and injustice would bring governments and people to share. Unfortunately, I do not believe that anymore. What I do believe, however, is that people and governments will react if they believe their own economic self-interests are at risk. And here we have the compelling motivation for change. We can and should use environmental threats as a way of backing into important development issues, because nation's economic self-interests are surely at risk, if we do not solve the environmental crises we face.

My third point relates to two of the principal conclusions of the Brundtland report. First, that the problems facing the global community are too complex, too holistic, and too serious for governments alone to solve. Rather, all key sectors of society must take part in the search for solutions and be at the decision-making table. Second, to achieve sustainable development, we must have both national and international political systems that ensure citizens' effective participation in decision-making.

Sustainable development, therefore, demands the creation and mobilization of constituencies for change in every part of the world, in every sector of human activity. And it demands involvement and partnership in decision-making, with resulting ownership of joint decisions.

Public participation is not simply an exercise in "consumerism." It cannot be restricted to consumption of the prepared flow charts and graphics that put scientific jargon into ordinary language. Rather, it must mean the public having a "right to know", and an active role in the determination of what information it needs and how that information is gathered, processed and disseminated. And it means a public role in identifying *who* will gather, process and disseminate the information.

Participating in the compilation and analysis of information on sustainable development is a function of power-sharing and the operation of democratic processes. But without that participation, the public will have little confidence in the information to which it has access.

Without this sense of ownership of the information and a clear understanding of the priorities of sustainable development, the need to clarify the public understanding of risks will not be met. And the public will not be motivated to make the necessary changes in their own lives to achieve sustainable development.

Without this sense of ownership industry and business will not be accepted as key players, and providers of solutions in, the move toward sustainability. There will be no room, politically or in terms of public opinion, to effect necessary changes in our international economic relations. There will be no tolerance of the timescales under which lasting change must be brought about, and there will certainly be no understanding of the need to move from short-term fixes to long-term solutions.

In our world and the one we are creating for the future, information will continue to be the engine of change. But that engine has to be fuelled with the insights and perspectives gained from broad public participation. Information, as politics, must be democratized.

Let me end with a warning. Information is more than just knowledge, it is power; and we are moving very quickly in the direction of creating two information worlds: one which has it and one which does not. But, when it comes to sustainable development, the holders of information can not become the world's new masters. Information on sustainable development has to become a common tool in our search for common solutions. In the 21st Century, information on sustainable development, like critical global resources, must become the property of the global community, and not of a technocratic or economic elite.

CLOSING ADDRESS

Marcel Danis, Minister of Labour, Canada

Mr. Danis was first elected to the Canadian House of Commons in 1984. He has served as Minister of State for Youth, Minister of State for Fitness and Amateur Sport, and Deputy Leader of the Government in the House of Commons. Mr. Danis holds a master's degree in political science form Fordham University, a diploma in constitutional law and political science from the *Université de Paris*, and a law degree from the University of Montreal. He is a member of the Quebec and Canadian Bar Associations and the Canadian Political Science Association, and has taught law and political science at Concordia University.

Address:

Ladies and Gentlemen, on behalf of federal Environment Minister Jean Charest and the Government of Canada, I would like to say how pleased we are with the outcome of this meeting. It will enable us to increase our awareness of the importance of environmental information as we move towards the 21st Century.

I am sure that my colleagues from Cabinet will appreciate the findings and recommendations that have been made during these three days of discussions and fruitful exchanges. In my view, this international forum was one of a kind, and perhaps the first to be devoted to the improvement of environmental information intended for decision-makers.

You were all invited to this conference because of your recognized expertise in this field. I would like to thank you for the excellent work you have accomplished here together. The forum will make it possible to determine more effectively the needs of decision-makers and the improvements that must be made to ensure that environmental information is truly useful to policy- and economic decision-makers.

I would also like to extend special thanks to the organizers of the forum, particularly Jean-Paul Gourdeau, the Chairman, and to its sponsoring organizations -- the United Nations Environment Program, the Organization for Economic Co-operation and Development, the World Resources Institute, the International Chamber of Commerce and the World Environment Centre.

The International Forum on Environmental Information for the Twenty-First Century set out to examine data collection, storage and retrieval techniques and ways of formatting and presenting environmental information. It also wished to learn from the experience of institutions that are already involved in the acquisition, analysis and sharing of this information.

The work that you have accomplished this week is of crucial importance because of its practical applications.

As the Federal Minister of Labour, and a member of Cabinet, I am preoccupied by many of the same types of issues you have been discussing here. Along with my Cabinet colleagues, I share your view that new partnerships must be formed among governments, non-governmental organizations, the business community, and academia for the purpose of strengthening the management and sharing of environmental information.

You have emphasized that environmental information must be adapted to the needs of decision-makers in all sectors, as well as on an international scale. But, it is also important to recognize that every inhabitant of this planet is a decision-maker. Every day, individuals make a variety of decisions that affect the environment. Accordingly, each person or group has somewhat different information needs.

In the course of your deliberations here, you have also endorsed the idea that there should regularly be more widespread adoption and implementation of state-of-the-environment reporting methods and processes by all countries. These reports would promote continuing data collection and management, and better environmental monitoring. State-of-the-environment reporting will ensure that governments act in a manner consistent with the long-term needs of the population and of the environment.

Decision-makers such as I require environmental information of this nature, presented in a balanced and accurate manner, to form a base for sound environmental policy. Your recommendations of ways to increase the amount of knowledge available in this field will help us to move towards anticipating -- towards preventing -- environmental problems in the future.

It is also crucial that we, as a government, share information, technology, and funds to ensure that developing countries are able to acquire adequate data-management systems to meet their needs. Environmental

issues are becoming, more and more, global in scope, and we must develop global solutions.

This meeting has given you an opportunity to take part in roughly a dozen workshops on various topics of interest to several participating countries. You identified three main reasons for compiling environmental information: first, the need to improve the integration of environmental decisions with economic, social and ethical decisions; second, the need to expand the obligation of decision-makers to be environmentally accountable; and third, the need to facilitate the implementation of public- and private-sector decisions, statues and international treaties and conventions. You also identified a number of areas that should be monitored by participating countries. These include global warming, air pollution, the export of toxic wastes to developing countries, desertification, soil erosion and deforestation.

But in many respects it was possible to observe that the production of environmental information in all countries is still in its infancy. All countries are grappling with the same problems, although their experiences and resources differ. Among the problems encountered are the lack of co-operation among the decision-makers from the various sectors, the lack of communication among producers and users of environmental information, and the difficulties in measuring certain environmental phenomena and their impacts.

In addition, developing countries are struggling with a lack of financial resources and are facing a shortage of qualified persons to collect, analyze and disseminate environmental information. On the other hand, developed countries lack information required to develop lasting policies on the use of resources and energy; this could result in further widening the gap between North and South.

In the course of your deliberations, you have identified a number of improvements needed to deal with environmental problems such as those I have just mentioned. You have also told us that nations around the world must work together with international organizations to develop a basic set of environment and development data, which could be refined over time to meet new circumstances. With improved mechanisms, countries can learn from each other's experiences, and cross-boundary comparison of data can then take place.

For example, all countries need to develop environmental information at the community and local levels. This is particularly true for developing countries, and we in developed nations have a responsibility to share our knowledge in this area, wherever possible.

Everyone agrees that there is no need to create major new global institutions devoted to environmental information to meet these many needs. Rather, existing institutions involved in environmental information must be given increased support and the ties among them must be strengthened at the regional and international levels.

Countries that are currently setting up national institutions for environmental information can learn from the experience of countries that have already established such institutions. It is widely accepted that the diversity of institutional needs and arrangements in individual countries must be respected, and that co-operation must be fostered through networking and information-sharing.

In the responsibility to produce and exchange environmental information, institutions and institutional arrangements cannot and must not replace citizens, communities or non-governmental organizations. Environmental information should be widely disseminated throughout the population, who must have free access to it. Greater transparency will only increase public confidence.

To this end, institutions and arrangements associated with environmental information will have to be more flexible, permanent (with an expected life of at least 50 years), and willing to submit their scientific and technical activities to peer review. They must also be completely independent in their operation.

The production of environmental information will require a coherent framework to guide its form and content. This framework should be based on the concept of sustainable development, and will have to take into account the relationships between biophysical effects and economic activities. This framework should make it possible for environmental information to be part of an approach focused on ecosystems and should respect the public right to obtain information on the state and/or quality of its environment.

I am pleased to note that you have agreed that the next important step in bringing these recommendations and ideas forward is for Canada to take the results of your work to the next Economic Summit in London this July. From there, your recommendations demonstrate that environmental information should be considered as a policy issue in its own right at the upcoming United Nations Conference on Environment and Development, to

be held in Brazil in 1992. The *Environmental Information Statement* will also be sent to national and international bodies for consideration -- many of these organizations are represented here.

Here in Canada, we expect that the *Environmental Information Statement* will help us meet our goal, stated in our *Green Plan*, of providing timely, accurate and accessible information to enable Canadians to make informed and sensitive decisions in the field of the environment.

The *Environmental Information Statement* will play a key role in the development of national state-of-the-environment reports and indicators. It will help us to establish a national environmental information network and the national organization that will be responsible for reporting on the state of our environment.

Moreover, the *Environmental Information Statement* may serve as a base for an international agreement on joint standards, measurements and information at the United Nations Conference on Environment and Development in 1992.

As you can see, this forum has been more than just a conference. It has allowed us to take a giant step forward. It is now up to each of you to implement, in your own country and organization, the main recommendations of this forum, to which you have made a signification contribution.

In closing, I wish you well in your continuing efforts. May you all have a safe journey back to your homes in every part of this world that, together, you are helping to protect. Thank you.

WORKSHOP DISCUSSIONS

THEME 1: INFORMATION NEEDS OF POLICY DECISION-MAKERS

Group 1

Chair: Leslie Whitby
Facilitator/Rapporteur: Don Gamble

ISSUES DISCUSSED

Needs and Aspirations

Collection of data and their translation into information for "policy" decision-makers (whether they are local, national or international, or in the public or private sector), should be related to benefits perceived by the user. Hence, we are looking at different needs according to values that may vary within any single jurisdiction; they most certainly vary between jurisdictions. There is a necessary socio-cultural component, and within that, a range of needs from those of the detailed research "user" to those of the more generalized, political "user". This diversity of needs, while superficially frustrating, is in itself a benefit: a kind of safety net or cross-checking mechanism that can be applied when knowledge evolves in new directions or social needs change.

Anticipating Requirements: The Role of Scientific Research

Policy decision-makers' day-to-day needs are not always what is needed to anticipate problems. Scientific research, much of which often seems "far out" to policy decision-makers, is necessary if long-term effectiveness is to be maintained. For example, the first studies on the ozone layer were undertaken without any sense that it was a "policy" or "human health" issue, but in those arenas, the work had more dramatic repercussions than in the apparently more abstract research arena.

Democratization Influence

The provision of relevant and timely information is inherently an act of empowerment. If the information is cheap and readily accessible, it is considered a powerful democratization tool. This leads to or encourages local action, which is helpful because it makes environmentally responsible decision-makers of individuals and groups. But it also has another side because it shifts power, creating political sensitivity where regimes may not wish to be held accountable in such a direct way. The benefits may not be seen to be positive, whatever the environmental relevance "on the ground."

The fact that political entities usually control environmental data tends to extend this problem. Credible, third-party sources of information may be necessary. Non-government organizations seem to have a role, as illustrated in India where there is a citizens' report on the environment. Canada seems to be heading in the same direction with the *Green Plan* commitment to establish an "arms-length" state-of-environment reporting agency.

Closing Gaps

There are some gaps that go beyond data series. These need to be addressed in both developed and developing countries.

In developed countries there are obvious gaps related to the kind of information gathered and how it is integrated into systematic "ecosystem-oriented" information. Canada, the United States and many others are trying to address this gap. It is not as if there is any well accepted system of gathering data and translating them into policy instruments anywhere. Powerful tools do not yet exist around which various interests can gather.

In developing countries the problem is further exacerbated by more pressing demands of scarce resources -- education, employment, health and the provision of basic life support systems. Unlike the situation in developed nations, here the environmental constituency is largely at the top of the social order among senior-government and private-sector officials. How do they sell the "need" to their constituents?

Clearly, with similar, fundamental environmental information needs, there must be global co-operative mechanisms. The support of developed nations has a large element of self preservation: we know that what happens in developing countries (from forest clearings to use of toxic substances), emerges as a problem for developed countries. The most insidious environmental issues are global.

Role for Development Assistance Agencies

These agencies have recently accepted incorporating the environmental impact assessment process before approving projects. This generates a need for various kinds of environmental information.

Project funding, however, provides a limited context for improving environmental information. The continuing, post-construction monitoring/feedback system is limited to a particular project. Environmental information collection and management require a longer-term commitment. Another type of lending could constitute this longer-term context: policy reform loans. These loans, if they were to incorporate environmental objectives, would generate the rationale for environmental information management for entire sectors or nations.

International Co-operation

Common needs dictate the global need for co-operative approaches to data collection and synthesis. This is self-evident, whatever the difficulties in achieving it. But there is more. The training and education of environmental researchers, analysts and policy-makers/advisors needs to take on more than a domestic focus.

What is the role of international organizations or leading developed nations? Exchange and gathering of data may pose immediate methodological problems but the simple sharing of "who is doing what" and "what each is learning as a result" can be done now. A forum is needed, one that is readily accessible to all. From it would emerge new ways to afford access, to share and interpret data for policy decision-makers. It may be possible to develop guidelines in fairly short order (at least on some critical matters).

Finally, information need not become a smoke screen to hide the obvious. For example, it is well known that prohibitions are in order internationally; it is not good enough to ban products or practices in developed countries only to have them emerge in less developed countries. There is little excuse for inaction when it is obvious that existing, more efficient and more environmentally friendly technologies are available. We should avoid "policy-analysis paralysis."

RECOMMENDATIONS

Whatever the specific needs of different policy decision-makers, the information should:

- be founded on the definition of sustainable development and have social relevance;
- be nationally integrated (ecosystem approach) and be harmonized with other international approaches;
- reflect social and cultural values;
- be supported by, and responsive to, a continuing science/research program;
- incorporate an educational component and have training programs, both aimed at adults and children;
- be readily accessible (cost, availability) to user groups;
- be based on priorities in all sectors and draw upon the strengths of the private, non-governmental and public sectors;
- be transferred to developing countries, possibly by pairing developing and developed countries to facilitate the transfer of methodologies.

Group 2

Chair: Pierre-Marc Johnson
Facilitator/Rapporteur: Jacques Paynter

ISSUES DISCUSSED

Decision-makers and Their Needs

The need to bring together the various users and producers of environmental information, including policy decision-makers, was seen as an important process by the workshop group. Discussions would build trust, and concensus on the application of environmental information.

Decision-makers require a well-rounded view of the environmental consequences of their decisions. At present, decision-makers have no overview of data availability and quality. They tend to react to public opinion and lack understanding of environment-economy linkages. This results in one-dimensional policies designed to respond to specific problems without taking into account all repercussions.

To ameliorate this situation, the decision-making process should follow the steps from problem identification, through policy priorities, to implementation and enforcement of policies. In addition, better information is required to provide decision-makers with a long-term perspective and the experiences of other jurisdictions in managing various environmental problems and solutions. The workshop group also discussed training for decision-makers, not in in-depth science, but in environmental

interrelationships, and the use and limitations of environmental information.

Data and Information Sources

Similarities and differences between global and local perspectives on environmental information and policy-maker needs were discussed. State-of-the-environment reporting at the global level was discussed by the workshop group. Written reports on the "State of the Globe" were not seen as particularly useful to decision-makers. Such reports could be improved by the addition of a regional or local context to complement the global perspective.

Global data bases were recognized as significant. Existing data sets, such as those of the United Nations Environment Programme, the Organization for Economic Co-operation and Development, and the World Resources Institute, were considered good by workshop participants; however, there were calls for an expanded base of improved information.

In addition, participants noted the imbalance of available data between developed and developing countries. It was suggested that important data questions for developing countries, including good data availability and gaps, communications infrastructure, and institutional arrangements, should be addressed by participants.

The workshop group recognized that, generally, environmental information exists, but, the appropriateness and comparability of information related to priority issues are often lacking or not satisfactory. Members of the group also suggested that the presentation and dissemination of environmental information to policy decision-makers and the public should be improved.

Participants called for open data and information systems in all countries, with access available to everyone. Information on data quality and collection methods should also be transparent and available.

Priorities for Information

Discussion on priorities led to recognition of two contextual frameworks: the need to move towards global sustainable development; and the current economic and fiscal constraints on most governments.

Types of information needed for decision-making were discussed. The group identified the following areas where improved measures or methods are required:

- economic cost of environmental damage, for example, soil erosion, deforestation;
- differences in public and private perceptions;
- the types of indicators required for policy decision-making;
- comparable units of measure between different environmental problems;
- loss of global biomass and its economic implications;
- risk assessment, including health risk;
- pollution loads measured against critical levels; and
- development of future scenarios requiring credible forecasts.

CONCLUSIONS

- Participants called for the transfer of additional resources to developing countries to help establish data gathering and management systems (for example, through World Bank environmental assessments). This will help improve the environmental component of national plans.
- A global database should be established to facilitate risks assessment for decision-making. Such a global dataset will be difficult to create because of such world differences as assimilative/carrying capacities.
- Standard indicators (parameters) are required and should be adopted by most countries. Such indicators should satisfy the following criteria: adaptability over time; feasibility to establish usefulness; significance; and relationship to major environments (land/air/water).
- Training was recognized as an important prerequisite for sound decision-making. Understanding of environmental models such as stress-response, environment-economy-health interrelationships, biophysical threshold, data management, and environmental information systems are required to improve the interface between information and decision-making.

Group 3[2]

Chairs: Christian Avérous, Janos Pasztor
Facilitator/Rapporteur: Pat Delbridge

ISSUES DISCUSSED

Six areas were discussed by participants in the two workshop sessions on the information requirements of policy decision-makers and on reporting environmental information. They included the following:

- What kind of data?;
- An improved framework for environmental reporting;
- Improving data and information quality;
- The special needs of Eastern European and developing countries;
- Balancing the rights of those wanting to preserve the confidentiality of information with the right to know; and
- Improved communication of information for environmental decision-making.

What Kind of Data?

A list of databases now used as information sources for environmental reporting was outlined by participants. The list included:

- statistical data (census data, environmental statistics, remote sensing);
- biophysical data (compiled in other government departments and by the private sector, including information from environmental impact assessment projects);
- data from international sources (for example, United Nations datasets, measurements of cross-boundary pollution, etc.); and
- information from state-of-environment reports.

The list of data sources seems to indicate a wealth of data. But, when attempts were made to aggregate the data so they could be used by policy-makers who wished to measure and track the state of the environment, it became clear that the existing data were not adequate and that large gaps existed.

The need to collect more information through improved environmental indicators was accepted by all participants. There was also general agreement on what kind of information was missing. Participants prepared a list that included gaps in our ability to establish a benchmark and track information in such areas as:

- ecosystem changes that could be measured over time in terms of biodiversity, habitats, human health;
- finding ways to measure and track the environmental cost of economic activities, such as agriculture, transportation, and manufacturing. This would include methodologies that could be used to establish true cost accounting in such areas as resource depreciation, clean-up costs, etc.; and
- finding ways to improve the ability of nations to collect data related to large-scale global phenomena, such as climate change, water quality, soil depletion, etc.

While it was clear that the need for consistent, reliable environmental indicators would become increasingly urgent, the barriers to meeting that goal were found to be formidable.

Participants from developing countries outlined the difficulties in establishing any priority for the allocation of scarce resources to environmental issues, given the more obvious social pressures in those countries. Participants from Eastern Europe spoke of the difficulty of access to information and, in many areas, finding the resources to measure a wider range of indicators. All participants were concerned with the fragmentation of data, the difficulty in finding where the data existed, and identifying how reliable the data were for aggregation of individual indicators.

[2] Group 3 workshop report combined the Discussion of Information Needs of Policy Decision-makers with Reporting Environmental Information.

An Improved Framework for Environmental Reporting

It was recognized that considerable work is now under way, in many international institutions and national statistical bureaus, on improved frameworks for environmental reporting. It was also recognized that integration of complex, multi-disciplinary data required the development of a new framework that would encompass data collection, processing and analysis.

Several opinions were expressed about the form this framework should take. One position was that existing indicators, such as the System of National Accounts and the System for Integrated Environmental and Economic Accounting, should be expanded, since they had the capacity to provide integrated environmental accounting in both physical and monetary terms.

A second position preferred that stand-alone models be developed. These would establish a specific methodology, providing a measurement of sustainable development that would, over time, become equal in stature to present economic indicators.

A third view was based on the concern that the search for an overall framework might delay the development of a broader range of simple indicators to meet the increasingly urgent needs of decision-makers in specific areas of environmental degradation. Such areas would include clean technology, pollution control, hazardous waste management, among others.

Participants thought that advanced technology offered ways of integrating diverse information, and so we needed to undertake development work to find innovative ways of extracting, displaying and assessing complex environmental information.

Improving Data and Information Quality

A great deal of discussion centred on the need to improve the quality of existing data so that they can become a more useful tool for environmental policy-makers.

Discussion was focused on two issues:

- the need for improved resources, training and skill development among information producers and users; and
- difficulties in validating existing data.

Need for Improved Resources

The difficulty in finding the necessary resources to collect data that can be used for improved decision-making on environmental issues was discussed by a number of participants. It may become necessary to further evaluate the usefulness of some existing data collection activities so that resources can be reallocated to measurements of environmental issues.

The need to improve the skill of data collectors in agencies and sectors important to improved environmental management (such as health, land use planning, energy, etc.), was considered a priority. It was suggested that attention should be given to strengthening the capacity of universities, so that the next generation of producers and users of information would be better able to meet the needs of the 21st Century in this regard.

It was also suggested that training and orientation resources would need to be provided, so that today's decision-makers could become more aware of the existence of environmental indicators and more skilled in their use.

Validating Existing Data

The need to integrate data from various sources into information upon which sound environmental decisions can be made also raised the question of data comparability and validity. Access to original data becomes an important issue, so that assumptions can be verified, and any analytical bias, ascertained.

Increased peer review in the collection and analysis of environmental data was suggested as one means of improving the quality of information.

The Special Needs of Eastern European and Developing Countries

As already stated, many participants from developing countries said that they had increasing difficulty in gaining the necessary attention for environmental issues where the overwhelming needs of hungry populations, of necessity, had priority. Group members from developing countries and Eastern Europe stressed the need for developed countries to recognize that resources, training and skill improvements would have to be made available. They were also concerned that the emphasis on finding a comprehensive framework for improved reporting of environmental information might reduce their ability to obtain resources for some basic data collection activities.

Balancing the Rights of Those Wanting to Preserve the Confidentiality of Information with the Right to Know

Participants agreed to propose to the plenary a recommendation that affirmed the need for access to environmental data and the right of the public to know the state and quality of their environment.

It was recognized that selective use and reporting of environmental data continued to be a problem in many countries and that mechanisms needed to be developed for improved access. Yet, the right of private-sector data gatherers to maintain the confidentiality of proprietary information was also recognized. It was expected that the movement towards increased use of environmental audits would open up new sources of data, which could be integrated into environmental measurements.

Improved Communication of Information for Environmental Decision-Making

The need for information providers to take a major role in the dissemination of information to the widest possible audience was recognized by participants. It was suggested that information providers should become more familiar with the wide range of electronic mechanisms through which environmental information could be disseminated. It was also thought that information providers needed to improve their ability to "package" environmental data; to communicate more readily with sectorial users and providers; and to become more skilled in using the media as a communication channel.

Information providers must recognize that, while the same "core" of environmental information can be used, they need to address different needs of a wide range of users. This adaptation will result in more and better use of information by decision makers.

ACTION ON ITEMS DISCUSSED

The following list was outlined as objectives or goals for action that will more effectively meet the environmental challenges of the future.

- Accept the premise of sustainable development for integrative data collection, and develop methodologies to better integrate environmental and economic decision-making at the national and international level.

- Develop an overall framework for the collection and analysis of data, so as to better serve the information requirements for the implementation of international agreements and to make national governments environmentally accountable.

- Work to improve the quality of data collected by:

  - improving the capacity of developing countries to collect and analyze environment-related information;

  - ensuring peer review of data for quality, consistency, comparability and compatibility at national and international levels;

  - including qualitative, as well as quantitative, data in collection and dissemination processes;

  - reporting environmental information in a broad context, as opposed to dealing with it sectorally; and

  - testing methodologies being developed for various environmental indicators and accounting systems in country case studies.

- Develop a framework for the collection of data according to sound principles of sustainable development. In the meantime, it is important to develop simple indicators that may serve as accurate predictors of environmental change.

- Consider environmental information improvement as an environmental policy action in itself.

  - foster the financing for the collection of strategic environmental information to help ensure sustainable development in developing countries, particularly in light of unmet needs of present generations;

  - emphasize capacity-building in developing countries, so as to make the collection and analysis of environment related information possible;

  - encourage countries to prepare national environmental plans and regular state-of-environment reports;

  - encourage the development of information on the economic costs and benefits of various actions; and

- encourage the provision of information on the state of natural resources and ecosystems.

- Generate and communicate environmentally oriented information for improved decision-making at local, national and international levels.

  - accept the notion of the public's right to know the state and the quality of their environment;

  - promote the packaging of information to meet the needs of different audiences;

  - explore different ways of producing and disseminating information to different audiences through the use of media, and other electronic instruments; and

  - ensure that there is a balanced effort, not only to produce environmental information, but also to transform and transmit it to appropriate target groups.

RECOMMENDATIONS

- Develop information to better integrate environmental and economic decision-making at national and international levels.

- Develop an overall framework for the collection and analysis of data, so as to better serve the information requirements for the implementation of international agreements and to make national governments environmentally accountable.

- Work to improve the quality of data collected.

- Develop a framework for the collection of data according to sound principles of sustainable development.

- Consider environmental information improvement as an environmental policy action in itself.

- Generate and communicate environmentally oriented information for improved decision-making at local, national and international levels.

- Promote a policy of the public "Right to Know" the state and quality of the environment.

Group 4

Chair: Phillip Ross
Facilitator/Rapporteur: Jessie Davies

The group accepted the general requirement for environmental information presented in a comprehensible, balanced, accurate and timely manner. Discussions were focused primarily on the most significant barriers with respect to communication problems associated with meeting these requirements. Some participants concentrated their contributions on current problems, rather than looking forward to the 21st Century, because severe problems face them at present.

General areas for discussion were:

- the problems associated with the lack of communication between disciplines of environmental science, and the lack of linkage and communication between the scientific community and the users of environmental information;

- lack of compatibility and comparability; and

- financial resources, cost-effectiveness and priority issues.

ISSUES DISCUSSED

- problems associated with attempts in the academic world to deal with environmental issues in separate faculties where the environment, by its very nature, requires an interdisciplinary approach;

- problems associated with the political timeframe of decision-makers and the long-term requirements of decision-making on environmental issues;

- the need for users to have access to the data they require where a "glut of unorganized information" is overwhelming and not suited to their needs;

- the need to include the social dimension in the concept of sustainable development, and the general need to identify information necessary for developing indicators able to reflect the effects of environmental impacts on the well-being of a society (social indices and indicators); and

- the quality of data.

The group presented a number of items that reflected the issues. These were not ranked, but, together with the issues, formed the basis of the subsequent discussions and recommendations on reporting environmental information.

Priority was given to addressing the requirements of different target groups for information. For example:

- policy decision-makers require concise information interpreted (without bias) and focused to assist them in the drafting of legislation and specific policies;
- the public needs accurate information, produced in easy-to-understand form, particularly in areas that can directly or indirectly impact on its well-being (for example, human health);
- the private sector (industry and business in particular) require information to assist in decisions about investment and development, and the environmental consequences of their decisions (the "big picture");
- sectorial interests (such as agriculture) need information specific to their sectors, but also information relating their activities to the ecosystem in which they operate.

RECOMMENDATIONS

The group stressed the critical role of information dissemination in the effective management of the environment. Improved dissemination of information for the 21st Century entails the identification of a variety of parties who have a vested interest in the environment, and the development of appropriate mechanisms for collecting, analyzing and presenting the information and promoting its understanding and acceptance. Consequently, the group recommended that the Forum focus its efforts in the information dissemination arena as follows:

- relating the significance of environmental information to human health and linkages with other parts of the environment;
- promoting credibility, understandability and avoiding uncertainties in the data;
- assuring that emphasis is placed on the need for peer review by information professionals and others; and
- responding to priorities enunciated by management officials and the public for ensuring the stewardship of the environment.

Group 5

Chair: Rolland Ramahatra
Facilitator/Rapporteur: Raymond Vles

The discussion touched on numerous issues related to environmental information. Delegates identified issues to be resolved and needs to be met in order to make progress.

ISSUES DISCUSSED

- Delegates underlined the importance of co-ordinating environmental information programs among countries in a region (such as the Caribbean). Such co-ordination is required to improve regional environmental management.
- The lack of political integration makes co-ordination of environmental information programs difficult. Differences in language, history, and development paths, the fear of loss of sovereignty, and conflict and mistrust between the private and public sectors were all factors which contributed to the lack of political integration.
- Developing countries also face a lack of trained human resources, funding, technology, know-how and technical ability. Efforts to remedy these deficiencies must deal with all these aspects -- what good is a piece of equipment in the absence of personnel knowledgeable in its use and maintenance?
- The harm caused by structural adjustment programs that disregard the environment and divert resources away from dealing with environmental concerns was recognized.
- With respect to existing environmental information, participants agreed that finding what they needed was often the greatest difficulty. They needed to know who to contact in which of the many international and national (especially foreign) agencies that have information.

- A delegate stressed the difficulty of integrating into the domestic database information on the environmental impacts generated by the harvesting of resources imported into the country.

RECOMMENDATIONS

The delegates identified the following items as priorities for action.

- Co-ordination between agencies: One participant suggested decentralizing data collection and centralizing analysis and interpretation. Another delegate suggested the need for both "one-stop-shopping, supermarket" types of agencies and specialized "boutique" types of agencies.

- Delegates expressed the desire to be able to learn from the experience of other countries. How have they solved the problems which now confront others?

- The need for more partnerships without duplication and overlap was stressed by the delegates.

- Data collection and analysis should be expanded to include unofficial (for example, informal economy, unorganized sector) and even illegal (for example, drug trade) economic activities and their environmental impacts.

- Indigenous, community-based information should be collected. This should not be done by imposing structure on the data, but by letting the people with the knowledge organize it in their own way. Their data should be combined with the more conventional, scientific data.

  By way of example, a delegate described how the Inuit in Northern Canada had been taught to use computer mapping to compile their unequalled knowledge of the natural resources in their area. Such information would not have been available by any other means.

- Information held by scientific institutions such as museums should be made available to the countries where the data were collected. A delegate from Peru noted that there were 1,600 pages of ecological information on Peru in the Smithsonian museum in Washington.

- There is a need for people who can interpret research results to decision-makers and the public. Reports are not always the most appropriate means of communicating information; graphic based methods should be explored.

- Delegates discussed the need for more environmental information, taking differing views depending on the problems they were facing. On some issues enough is already known; the difficulty is not with information, but in taking appropriate action to solve the problem. On other issues, for example, health impacts of air toxics, the problems are not well understood and, therefore, more information is required.

- The need for harmonization of data collection methods was underlined by the workshop participants. A delegate raised the question of the type of technology required to comply with data collection standards. If the technology is too complex or expensive, the developing countries will not be able to conform with standards. It was suggested there could be two levels: a "high tech," expensive standard and a "low tech," inexpensive standard.

- Environmental information should be related to the priorities of the national development plan. This will make it more relevant to decision-makers and limit duplication through better co-ordination. Such information should generate savings that should be applied to improve environmental information collection.

Group 6

Chair: Graeme Oakley
Facilitator/Rapporteur: Maureen Payne

The workshop task was introduced by the chair in the following terms: all Forum participants should discuss this theme because of the importance of understanding the information needs of decision-makers. This importance is reflected in the need to provide quality information for informed decision-making.

The workshop discussion used the David Pearce and Shirra Freeman paper, *Information Requirements for Decision Makers*, as its starting point. This paper provides a summary of information needs, gives the criteria for setting priorities, and identifies some current gaps in the context of the global policy objective of sustainable development.

The workshop membership included representatives of developing and developed countries, users and producers of environmental information, and people in both categories. Some of the users were closely associated with political decision-making levels. Most of the participants spoke from a national perspective, versus an international perspective, and so raised examples of national problems that could be related to global issues.

ISSUES DISCUSSED

The participants focused upon the need for developing countries to benefit from the experiences of, and models formulated by, the developed countries. They took a strong view on co-operation and participation among countries. While progress varies from country to country, and some are further advanced than others, the participants did not want to see this as divisive.

The participants agreed with the authors' definition of sustainable development, that is, "ecological sustainable development," with capital depreciation investment and sustainability considered as part of the whole model. It was also agreed that all nations' accounting systems should incorporate not only capital depreciation, but also an improved indication of human well-being, since this is the ultimate goal of sustainable development.

One exception from the Pearce-Freeman paper concerned business sector's need for environmental information. Their need was not the same as government's need, according to the group.

"Many companies are producing information voluntarily because they believe it is their corporate responsibility," said one independent producer of information.

What Environmental Information Do Decision-makers Most Require?

Who are the decision-makers?

Considering that decision-makers include a broad range of members, including politicians, various levels of governments (both international and national), and international agencies such as the Organization for Economic Co-operation and Development, the World Resources Institute, the United Nations Environment Programme and others, the information needs are both general and specific.

As one senior government representative said, "Who are we talking about... issues related to each group differ and efforts vary." Each country will have its own set of challenges.

It was agreed that there were areas where a common base could be reached:

- geographic concerns at the national and international levels;
- use and the user (senior officials, although local institutions are significant); and
- three different levels of information needs are required by decision-makers:
  - physical/biological;
  - information directed to other than environment ministers, such as economic decision-makers (for example, finance ministers); and
  - global/international (trade, aid and others) and transboundary issues.

Priority areas of environmental information needs include:

- soil use/land use;
- deforestation;
- biodiversity;
- hazardous materials, and in particular, the export of toxic waste to developing countries;
- legal and administrative -- the need to draw upon information from countries with already formulated statutes and laws; regulations and continuing policy development; the sharing of such information to assist in the setting up of legal and administrative frameworks, particulary for developing countries;
- crisis information: floods, and other natural and man-made environmental disasters.

Special concerns of developing countries include the following:

- International agencies should be encouraged to assist institutions on the collection of basic data in such areas as fisheries, forestry and harbour pollution; developing countries require assistance in problem identification.

- The developed countries should assist the developing countries by identifying the information of "most" importance to developing countries.

- The evaluation of environmental agencies in developing countries is important.

- There is a lack of skilled people and infrastructure to collect, analyze, and disseminate environmental information -- in fact, some developing countries have not progressed very far.

- Developing countries often lack environmental information at the local and national levels.

- Developed countries should be prepared to give data to the developing countries in order to provide the advantage they require, particulary on issues of the global commons (for example, global warming and atmospheric issues).

- In the area of remote sensing, during the past decade, great advances have been made; this information should be made more available.

- Where satellites are operating, the flow of information should be increased, providing greater access for developing countries.

- The information needed is wider than statistical; these countries also require environmental pollution indicators, information about technological development for prevention and treatment, and institutional and legal information (for example, what different systems are important for assessments, both administrative and legal).

- The developing countries also need information on different ways to support environmental policies and financial systems.

- Lack of funding continues to be a major problem.

The world-wide issues are:

- Resources are always scarce for collection, analysis and dissemination of information, thus funding continues to be a problem for all nations.

- There is a need to continue looking for information that will assist humankind to cope with complex environmental systems in order to achieve ecological sustainable development.

- Information needs continue to change and will continue to change.

- Harmonization and streamlining of information systems and methodologies are essential, as is the appropriation of financing systems.

- Partnerships among industry, government and non-government agencies (producers, suppliers, policy-makers and decision-makers) are essential for the future. Many success stories were told of how non-government organizations and governments have worked successfully together in this area.

- Sustainable development: each country should meet it in its own way, since the issues in developed countries differ from the developing countries. Different sets of problems occur from one country to another.

- On issues of cross-boundary concern, there is a need to manage the limited set of indicators.

- Support is required for an information needs assessment, and a strategy of development.

- Greater support for national institutions is needed where they are more directly involved in the issues.

- Information that is communicated to the public should be improved.

- There is a general lack of effective linkage between suppliers of environmental information, including the different disciplines (for example, agriculture and forestry); there is a similar lack of linkage between countries, which limits the opportunity for sharing data.

- There is a general lack of management information systems (which include systematic data collection, monitoring, analysis) and decision information systems.

RECOMMENDATIONS

Recommendations were categorized on an international and a national level. The five key points from each category were presented to the workshop plenary.

International

- Acquire better information on consumption of non-sustainable resources.

- A directory of information resources is required, locating publications, data basis and other information in order to increase activity of international institutions disseminating environmental information.

- Institutional improvements and better linkages are required between international, national and regional agencies.

- Decision support systems and organizations should be institutionalized at all decision-making levels.

- Establish regional environmental information and analysis centres to co-ordinate, network, monitor and report.

- Increase funding and look for new sources for environmental monitoring and assessment, and reporting:

  - the Global Environmental Fund should dedicate 10 per cent of funds to monitoring and assessment activities in developing countries; and

  - bilateral donors should be encouraged, to develop strategies for funding data collection and assessment activities in less developed countries.

- Any future set of agreements (treaties and conventions) should be carefully reviewed for information needs.

- Institutional Information Assessments: assess institutions and develop mechanisms for assessing environmental information activities within institutions.

- Strengthen the role of international agencies to monitor global environmental problems: assess roles and functions; review international treaties and conventions, both current and proposed; and communicate and share, at reasonable cost, environmental information.

National

- Strengthen the legislative and administrative mandate for environmental information.

- New partnerships: encourage governments to develop new partnerships with non-government organizations; business communities; and academics to strengthen environmental information.

- Support the open flow of information and share information among governments, non-government organizations and the private sector, and between institutions in the national and the international community.

- Put in place an efficient donor management strategy which will ensure sound national approaches to the transfer of environmental information, including technology.

- Upgrade the role of environmental ministries in developing environmental information, for example, to make it more accessible.

- Incorporate environmental information policies into the mandate of other sectors, such as energy, agriculture, transportation and industry.

THEME 2: MONITORING AND DATA MANAGEMENT TECHNOLOGY

Group 1

Chair: Ramnik Parekh
Facilitator/Rapporteur: Don Gamble

ISSUES DISCUSSED

Priorities

Cause-effect links and ecological processes must be understood and assessed, as well as air, water and land issues. Relative importance is defined by the local user's needs.

The World Bank lists five priorities: habitat and biological diversity; pollution; protection of the global commons; land degradation; and freshwater resources. While acknowledging the logic of this approach, the group insisted that other related themes should be priority areas: for example, education/training; the dissemination of information, and oceanic data; and basic data in developing areas such as Africa.

The data resource initiative sponsored by the Netherlands is having particularly valuable results. If, however, there is to be a list of priorities, it should include natural

disasters, freshwater resources, effects of deforestation, and ecopathways for toxic chemicals.

The priority discussion again raises the issue of a framework (global, national, and regional/local) within which priorities can be established and funding allocations made. Three elements suggested for the framework were: quality, pressure and susceptibility. These could be usefully addressed on a "watershed basis," recognizing external influences such as the long-range transportation of pollutants.

Context

Why is it so difficult to assemble the total environmental picture from individual pieces? The fact that this is the case suggests some basic methodological and communication problems in monitoring and data management technology. Some elements of these problems, such as education, training and funding, were easily identified and were addressed in the discussion. Other elements seem more elusive and will require more in-depth examination. For example, there is a consensus that scientific research, factual and expert systems, non-government organizations, the private sector, and others all have a vital role. But exactly how each fits and the extent of the role for each are uncertain.

Other contextual issues are more obvious. Current problems arise from past monitoring approaches; formerly, we were more interested in resource management data (for example, river flows) than environmental quality data. So, we are changing the very context of many of the monitoring exercises. This context has professional and institutional implications that, in themselves, take time to address.

It is also apparent that the demand for the free flow of information has greatly increased while the means (even willingness) to provide that information has not kept pace and, as we move to more "ecosystem" and "sustainable development" approaches, new links have to be established between more traditional media-specific or discipline-specific programs. Add to this an urgency to address prevention at source, instead of "*post-facto*" and the need to go further to understand social and economic causal links (for example, between poverty and deforestation), and the present dilemma, however frustrating, is understandable.

Scientific Research Underpinnings

In many cases, science is simply not yet able to make sense of whatever is monitored. In some important areas (for example, indicators) we are not confident about what it is we have even to look for. Continuing commitments to basic and applied research are obviously needed. Immediate needs are apparent in establishing monitoring standards, methodologies, classification systems and data interchange formats. One of the greatest challenges to scientists will be to make results understandable or "user friendly" for decision-makers and local users alike.

Local Empowerment for Local Action

If meaningful change is the goal, then information will have to be gathered and provided freely to the local user/decision-maker. Rapid appraisal techniques, such as those being developed by the US Forest Service, seem to offer promise in this regard. Not only is there the advantage of local gathering of data, but also that they are locally understood and used; these are two goals that should orient most monitoring exercises.

Large, central databases have a role, but at the same time, there must be local/regional access and, perhaps, control. But whatever the monitoring of database scale, the truism holds that most solutions to environmental problems manifest at the local level.

Monitoring: Methods and Links

There are very well established methodologies for water, air and ocean monitoring. What are obviously missing are methodologies for biological measurements ("bio-indicators"). This must be addressed as a priority.

It was suggested that, where the methodologies are established, there are comprehensive monitoring programs. The difficulties appear to be four-fold. First, the linkage among them is not established. Second, there are many capabilities that are not being utilized (for example, World Weather Watch). Third, knowledge about the monitoring program, its functions and applications seems limited (it is almost unknown at the local level). Fourth, the social implications of the data often remain unstated or vague. Addressing these difficulties by creating a monitoring program database "index" would not be expensive or difficult. Embarking on an education and training program, especially for developing countries, would be worthwhile.

As described above, what we are monitoring for has changed over the last decade. There is more emphasis on trends and particular demands related to policy directions, including compliance monitoring (arising from international protocols, etc.) This includes management

results monitoring -- tracking institutional, legislative, and even enforcement responses.

One particular challenge that must be addressed is how to change from technology-driven approaches in remote sensing to a more solution-oriented approach. What is needed in developing countries are cost-effective, simple tools that can effectively integrate data -- what is described as "user driven technology."

Development and distribution of complete kits that have data, software and a model to work with have proven to be useful. This approach should be expanded. It would be further enhanced by the provision of cheap (satellite) means of data transmission from field stations to central sites.

Education and Training

Education and training are considered a core challenge to be addressed in any future programs. Without them, there is little hope of significant improvements.

The focus is on developing countries, but not exclusively. It is apparent that in developing countries there is widespread ignorance of the type of monitoring programs that exist, what they do and what they are capable of doing. It is equally apparent that the technology and information have outstripped many decision-makers' ability to use it.

The education and training component must be comprehensive. It is needed to build awareness and disseminate knowledge, a continuing process. But the expenditure is, in many ways, not optional -- it is essential to our survival. It is not a split between developed and developing countries, either. The global threat means "we are all in this together." It is a threat more serious than a military threat. Environmental intelligence must become more important than military intelligence to G7 nations.

Funding

How can the costs of global monitoring and data management technology be covered? The group made a number of observations:

- We have no choice.
- The benefits will exceed the costs. For example, a Canadian study has shown that the benefits of water quantity data exceed the costs by 20:1.
- An option would be to look at one of the most polluting sectors -- energy -- and impose a tax (perhaps $1/barrel) to fund environmental monitoring and technology transfer.

RECOMMENDATIONS

- Theme Paper 2 (by Croze and Vanderweerd) is a sound base for the establishment of monitoring/data management technology for environmental assessment.
- Special attention should be focused on *linking* mechanisms among and between global and local/national initiatives.
- *Training* and *education* must be addressed as a matter of priority, especially in developing countries.
- There should be greater *co-operation* and innovation in standardizing and harmonizing methodologies and indicators.
- Given the magnitude of the global threat, new funding mechanisms are needed to support a renewed world-wide monitoring system that is "user friendly" and supportive of regional assessment and reporting initiatives.

Group 2

Chair: Luis Guerra Garduño
Facilitator/Rapporteur: Jacques Paynter

ISSUES DISCUSSED

Participants discussed the following issues:

- Decision-makers should not act on data alone but should also rely on other elements, such as the human dimension, to capture information.
- In the developing world, appropriate technology should be applied to help countries gather information required by the "world" community (for example, fish stocks/catch in oceans). Complex technology is not desirable; honest reporting and accurate aggregation are most effective. Yet, developing countries need an effective science support system to help them organize information and use it accordingly.

- Dissemination and international co-ordination of environmental information are urgently needed. Although there is competition over some forms of data to protect commercial activities, there are also jurisdictional issues that act as constraints to the sharing of information.

- Monitoring and dissemination of data are essential as they carry short- and long-term benefits to decision-makers. Various institutions should be involved in monitoring and in examining different sectoral issues, but, homogeneous methods and communication techniques should be used.

- Monitoring of particular ecosystems such as the open ocean by the Global Environment Monitoring System, should be completed. This would enhance the integration of information from various sectors. Still, problems of harmonization (the Harmonization of Environmental Measurements Program, for example) would have to be examined.

- There is no global inventory of the major data gaps; only sectoral inventories exist.

The group examined four key questions: data comparability, data quality, education and training, and disparities between developed and developing countries.

Data Comparability

The best approach to international data comparability is the development of sector-based institutions to support the exchange of data and co-ordinate the activities. These institutions should also ensure comprehensiveness of data, develop guidelines for acceptable measurements as well as methodologies, and identify gaps and recommend ways to resolve them.

Quality of Data

The question of how to get good data from resource users was discussed. Quality of data can be ensured by making data a part of discussions, and establishing guidelines to that effect. There are many good manual data gathering systems, for example, in India, with its low technology famine warning system that could be applied to other developing countries.

Technology should also be made more democratic. There should be more collaboration between the developing and the industrialized world to share data gathered by high technological means (for example, satellite sensing to forecast locust migration in Africa).

Education and Training

The question of monitoring and whom it benefits was part of the discussion. Workshop participants pointed out that nothing was being done to establish centres of expertise for the developing world. Many experts from developing countries, trained in the industrialized world, choose to remain in developed countries. This results in a lack of expertise in the developing countries. Furthermore, more education on management of natural resources and monitoring activities should be made at the public-school level.

Disparities Between Developed and Developing Countries

In order to overcome disparities of technology and monitoring capabilities between developed and developing countries, there is a need to have satellite images freely available to those who could use them to monitor change. Many governments charge for use of high-resolution imagery; some governments charge only for the cost of reproduction of data.

There is also an information management disparity where local expert training is lacking. Information exchange should be promoted between countries at all levels. This will require distribution of software thoughout participating countries.

RECOMMENDATIONS

- Harmonize data gathering guidelines for different types of measurements and rules of confidence intervals.

- Encourage international efforts between countries to share their experience, data collections and results of their analysis. Costs of *not* monitoring should be weighed against resulting economic consequences. This would result in a national data system from which countries, regions and the international community would benefit.

- Develop an inventory of methodologies, for example, hardware/software for environmental monitoring, which is sector-specific, and which is widely disseminated mainly in developing countries.

- Encourage major development banks to prepare an inventory of non-government organizations in various areas of activity and to exchange information at bilateral levels.

- Bring forward to the United Nations Conference on Environment and Development the following propositions:

  - Strengthen state-of-environment reporting (every four to five years, in synchronization with census data) as a moral and mandatory system for all countries; elaborate how and when this will be done.

  - During the next year, identify existing non-governmental organizations and their mandates. There are many environmental non-goverment organizations. This inventory should identify those organizations with clearly defined objectives and permanency. Data collected as part of bilateral and multilateral programs should remain as databases in countries of origin.

THEME 3: REPORTING ENVIRONMENTAL INFORMATION

Group 4

Chair: Jim Collinson
Facilitator/Rapporteur: Jessie Davies

Group Four decided to preface its recommendations with a statement expressing the need for a conceptual framework for environmental information, for sustainable development, based on ecosystems. Further, knowledge of one's environment is a *fundamental human right*, which implies that environmental information should be reported and available in a readily understood format.

ISSUES DISCUSSED

Issues ranged from the very general to problem specific and related to the countries represented by various participants. Discussion began with a round table, with each participant offering for consideration, issues and concerns associated with reporting environmental information, including:

- problems of information flow with a great number of information generators; for example, in Australia, where most environmental information is gathered by municipalities;

- transparency problems in environmental information;

- links (and lack of linkage) between the scientific community (which is "licensed to deal with the truth") and policy area. Discussion included the dichotomy of objectives between the academic community and the information needs of decision-makers;

- corporate environmental audits and corporate accounting, and the need for disclosure -- the tradeoff between the need to know on the part of the public and government, and the confidentiality traditionally associated with environmental audit information by the private sector;

- needs of countries (such as Chile) where environmental issues are still being defined -- the need to progress from the "fireman" reaction to environmental problems, to an anticipation approach based on adequate information;

- problems associated with the best visualization of data -- different end user requirements;

- specific needs for information for the transition period in Eastern (middle) Europe as the countries move from a centrally-planned to a market economy;

- co-ordination of data between jurisdictions;

- accessibility of information/simple language:
  — quantity (glut) of information;
  — digestibility of information;

- problems associated with interpretation of information by non-scientists;

- the right of the public to know the consequences of environmental impacts, especially with respect to public health and safety;

- the problems associated with the role of the media in the dissemination of environmental information and misinformation;

- availability of appropriate information for user needs;

- tools to convey information on environmental change;

- indicators and indices;

- need to set priorities for the gathering and dissemination of information:

  — funding priorities?
  — problems associated with bias and value -- interpretation and neutrality;
  — caveats where uncertainty exists -- how to present and how to make assumptions transparent;
  — when to publish? degree of review required?
  — credibility.

The group agreed that everyone is a user of environmental information but users can be sorted into different market categories. It is essential that information not be defined around specific user groups. For example, the agricultural sector needs more information than the usual crop yield data. It is important to present the "bigger picture" and put agriculture within the context of the affected ecosystems.

Collection methods vary between countries and depend on the resources available. It is sometimes possible to obtain the necessary information with limited field surveys and interviews with local contacts, and without sophisticated technology. The problems associated with the availability of the necessary scientific information were recognized, particularly with respect to the ozone layer.

It is important that information needs be defined by users and not be driven by available technology.

A specific need was mentioned for West Africa: that industry should contribute money for the collection of environmental information.

ACTION ON ENVIRONMENTAL INFORMATION

There was general consensus that some conceptual framework was required to clarify what information was necessary. It was agreed, however, that no acceptable conceptual framework presently exists. Although there was consensus that any framework to be developed should be based on the concept of sustainable development, there was considerable debate about the necessity of including the concept of an ecosystem as a basis of this framework. The debate here centered on definitions, primarily of "sustainable development" and "ecosystems." Participants agreed that both concepts were important, but without specific definitions to guide them, some had questions whether sustainable development encapsulated the concept of the integrity of ecosystems.

The goals for action to carry environmental information over the next century to relate to the environmental challenges of the future were not explicitly discussed. The group did identify the following goals in their discussion of issues and concerns:

- that information be made accessible in a form understandable to various user groups;
- that information be made credible and have adequate peer review;
- that information be made available, both as raw data and in an interpreted form so as to be appropriate for various user groups;
- that a System of National Accounts be developed to indicate the current state of the environment nationally;
- that a conceptual framework be developed to clarify requirements of environmental information; and
- that information be credible, and without bias.

There was no discussion on achievements to date. Reference was made to the importance of continuing research into the development of appropriate indicators and indices.

RECOMMENDATIONS

- The business/private/corporate sector should be encouraged to report, regularly and systematically, environmental information relevant to its operations.
- Guidelines should be prepared for environmental performance statements, for reference by companies throughout the world, to thereby complement existing work on environmental auditing. The group recommended the continued development, application, standardization, and evaluation of effective vehicles for reporting environmental information (such as state-of-the-environment reports; indicators/indices; impact assessment; risk assessment; sustainable development; visualization; and others); and compilation of a report comparing the various approaches and providing guidelines for their use.
- Further research and development on environmental indicators, indices and other data visualization approaches was recommended to provide appropriate

formats for greater public understanding of environmental conditions and trends.

- The group asked the forum to *strongly* recommend to G7 and other donor countries that adequate funding/resources be provided to appropriate international organizations for implementing the recommendations on improving environmental information.

- The quality and adequacy of the available environmental datasets must be specified as they relate to an issue. If possible, these should be assessed by a non-proponent agency or country.

- A global electronic file on "who is doing what" should be established, including:

  — a description of the work;
  — a list of available publications, data collections; and
  — a list of the experts who may be contacted.

  Such an electronic file would be made available on the Global Electronic Network (GEN) now being used by the United Nations Conference on Environment and Development.

- Care must be taken to ensure that peer review occurs before information or concepts are accepted and distributed for general use. Information systems such as newsletters are needed to prepare and distribute synopses of such material.

THEME 4: INSTITUTIONAL OPPORTUNITIES

Group 5

Chair: Gertrud Hilf
Facilitator/Rapporteur: Raymond Vles

The major theme of the workshop was the institutional framework for the collection and analysis of environmental information. For many delegates, the main issues were how to acquire the finances, know-how and technology to set up environmental information systems and how to gain access to the information that already exists in various national and international organizations.

Most of the workshop was devoted to an exchange of information among delegates about the situations affecting environmental information in their countries. They also described their experiences in the collection and analysis of environmental information. From the issues raised in the discussion of these concrete experiences, recommendations were made on improving the institutional framework for environmental information.

ISSUES DISCUSSED

Respecting Diversity

The diversity of agencies involved in the collection, analysis, interpretation and dissemination of environmental information is valuable and must be respected.

The principle that the agency closest to the problem should be responsible for the environmental information relating to it must be applied.

The desirable characteristics of environmental information agencies are:

- flexibility and adaptability;
- permanence, a life of at least 50 years;
- independence from undue influence from government and corporations; and
- openness to peer review of the information gathered.

Reinforcing Co-ordinating Bodies

Co-ordination is needed to bring order to the diversity of environmental information agencies. Co-ordinating bodies are needed at the national, regional and global levels.

The tasks of co-ordination are to:

- be a source of information on where to find the information needed by users;
- support the standardization of methodologies and technologies used in the collection of data; and
- develop environmental indicators.

Global Referral Centre

Delegates, especially those from developing countries, experience problems in finding the environmental information they need. They described the difficulties they had in trying to locate information in the large number of international and national agencies that collect environmental information.

Delegates recommended that a referral centre for environmental information be created. The goal of the centre would be to identify the agencies who can best respond to specific information requests.

The centre would:

- be located in an existing agency;
- have a small staff;
- facilitate data access; and
- provide feedback to data collectors on the use of their data and the needs of data users.

Open Access to Data and Sharing of Information

Delegates thought that more openness is necessary to increase public trust in environmental information. Better ways are required to communicate environmental information beyond the small population who read reports.

There is also a need to overcome valid constraints, such as confidentiality, on the sharing of information, through such techniques as the aggregation of data.

Funding and Legislative Backing

Delegates thought that legislative backing for environmental information agencies should be obtained wherever possible. Political commitment at the highest level is required.

Special measures are needed for funding. The elimination of duplication through better co-ordination should generate savings that should be applied to improving environmental information. Structural adjustment programs, which frequently require reductions in government spending, should maintain funding for environmental information programs.

RECOMMENDATIONS

- The principles governing the institutional framework for environmental information should be diversity and co-ordination. Diversity is important because it enables the environmental information system to be sensitive to local needs and conditions.
- Co-ordination is necessary to ensure that the information gathered can be aggregated to provide a larger picture. Co-ordination is also important for eliminating duplication and overlap, which waste scarce resources.
- Establish a global reference centre.
- Sharing environmental information and opening access to data are important.
- Establish legislation and funding programs to help environmental information agencies.

Group 6

Chair: Janos Vargha
Facilitator/Rapporteur: Maureen Payne

Countries and international agencies should play a more active role in managing information as a strategic resource, making best use of existing national and international resources, according to the workshop group. New partnerships and commitments must also be made between governments, international agencies, and the private sector in developing and developed countries.

While unique problems exist within developing and developed countries, there appears to be evidence that data are fragmented and often insufficient or non-existent in many parts of the world.

"The right to know" was a consistent theme of the discussions, in support of the open flow of information, and information sharing between governments and non-government agencies.

ISSUES DISCUSSED

The discussion was based on Theme Paper 4: *Institutional Arrangements and Environmental Information Needs* and complemented discussions held by

the same group on Theme 1: *Information Needs for Decision-makers*. Theme Paper 4, by Shuzo Nishioka and Yuichi Moriguchi, analyzes the institutional arrangements for managing the environmental information required for decision-making processes that foster sustainable development.

Many areas of concern within institutional arrangements were covered, including the eight outlined below.

Role of the Private Sector

A market exists for more private-sector involvement in data collection and dissemination. Two questions arose:

- what are the needs of the private sector? and
- what could be their role in terms of contracting-out?

According to one delegate, increased private-sector involvement may improve the efficiency, as well as the collection of larger volumes of environmental information.

Integration of Environmental Information

The next generation of environmental information should be the responsibility of all ministries. Integration and accessibility are important issues requiring an improved institutional response.

There was agreement that it is necessary to collect data from all over the world, however, it is even more vital to ensure that cross-ministries within nations are integrating information.

Data Collection

While there was no agreement on whether there was too much or too little data, there was agreement for a global information network. For the developing countries, data collection is difficult because of a shortage of resources. This requires a sharing of data from the developed countries. Financing programs aimed at the developing countries were suggested. Other issues on data collection included:

- decisions are being made from inadequate information;
- developing countries are unable to develop strategies for wise resource management, because of poor data;
- often decisions are based upon public opinion rather than scientific conclusion (that is, poor supporting data);
- data systems are not readily available;
- there is a need for socio-economic data demonstrating monetary value;
- there is a need for sufficient data to judge some key environmental issues;
- there are serious problems with information flow;
- there is poor linkage between national and international levels; and links differ from country to country;
- data should be collected at the local level, rather than globally;
- stages of growth in data collection vary between the developed and developing countries; decision support centres are required. An example of one country's success was discussed and provided evidence of how it is possible to become highly sophisticated in a matter of five years, due to the development of an information management unit focusing on decision scenarios;
- adequate evaluation mechanisms for international agencies are lacking;
- systematic documentation of national and international institutions is lacking; and
- information systems require overhauling -- valid and transparent indicators are required.

New Partnerships for Data Collection

Partnerships on data collection are possible, with government, private sector, non-government organizations and others. However, there are some risks with the non-government organizations participating in data collection. For example, they must be prepared for criticism, as industry often does not like to see non-government organizations collecting data. Nevertheless, there are many successes and great potential for non-government organizations to collect and manage data collections.

Review and Assessment of Institutions

The issue of review and assessment of institutions was dominant. While the delegates agreed that the Forum was an encouraging step, they also agreed that formal value assessments are required in order to ensure that "the right course of action is taking place on an on-going basis."

With the United Nations Environmental Programme and some of the other institutions at 20 years of age, the time has come to assess, evaluate and rebuild these institutions. The delegates were also reminded that a wait of five or ten years may be necessary because of the changing roles of some of the organizations.

No clear direction was proposed on who should do the assessments, although some built-in mechanisms exist.

Financing

New funding formulas for environmental monitoring, assessment and reporting should be investigated in order to find solutions to the cost of generating data, particularly in the developing countries. One concept was that a special fund of the World Bank should be identified as a resource for developing countries to use for environmental information purposes.

Need for Greater Co-ordination

Given the emphasis on ecological sustainable development, there is potential for differences in methodology. There is also a need to harmonize and to avoid duplication. Questions were asked, such as: should the co-ordinating role be given to existing institutions or should new ones be developed, or would a network satisfy the need?

The group agreed that a network should be designed so that different information is provided from governments and non-government organizations. Thus, the network would reflect the total contribution, rather than a series of separate processes.

Regional Data Centres

Nations should organize and take the lead in data collection. As well, consideration should be given to province and state responsibilities.

Relying on the UN for data collection was not considered a realistic option. New opportunities must be investigated. Collection of data at the most local level possible was a principle supported by all workshop members.

Establishing regional centres in various parts of the world was one option discussed for improving global data. For example, Brazil, due to its role in forestry could be a world centre for forestry data; Japan, the fisheries centre, and so on. The delegates proposed certain countries that could evolve as data collection and assessment centres. These regional centres would be linked into a global network.

Further discussion took place on how international organizations are evaluated. For example, World Bank information is privileged. The World Bank collects a tremendous amount of information that is not publicly available because of the nature of the institution. Nevertheless, the Bank does collect a lot of valuable environmental information on many countries.

CONCLUSIONS AND RECOMMENDATIONS

- There was general acceptance of the use of the definition of ecological sustainable development as a basis for organizing the conceptual framework for environmental information.
- Partnerships: the delegates reiterated the need for greater co-operation among environmental information institutions.
- Data should be provided at no cost to developing countries. At least one national centre is needed to provide access to electronic information. Regional centres should be part of a global data management plan.
- There should be further investigation and co-ordination of environmental standards set by each country.
- An information needs assessment should be completed as a first step in developing national environmental information development strategies.

Theme Paper One

Informational Requirements of Policy Decision-Makers

by

David Pearce

and

Shirra Freeman

Department of Economics
University College London
United Kingdom

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The Demand for Policy-maker Information

Introduction

Managing the environment for sustainable development

There is now a widespread recognition that in addition to traditional regulatory approaches, managing the environment entails managing the economy in an environmentally sensitive way. In turn, managing the environment is essential for sustainable development.

The focus of this paper is on the information needs of policy-makers within the context of sustainable development as the global policy objective. Therefore, the question is, what sort of information is required, and in what forms, to design and administer policies aimed at achieving sustainable development, over both the short and the long term? Information needs for more narrowly defined policy goals — that is, the work stages on the way to sustainable development — will be discussed in terms of the different types of policy-makers, the available information (e.g., indicators of environmental quality, state of scientific knowledge) and the efficient collection, analysis and communication of data.

Table 1 summarizes some of the results of a recent survey of Canadian users of environmental indicators. It captures a large number of "user-defined" needs that relate to policy design.

Table 1
User-defined Information Needs

- Indicators should be relevant to people's lives; that is, they should relate to the things that people value and be reported in a way that makes this relationship readily understood.
- Credibility and general acceptance of indicators are needed if they are to be useful guidelines. Most people may not need to understand the details of developing an indicator, but they do need to know that such an indicator is widely accepted among experts as valid.
- Indicators should represent matters which require attention and action.
- Indicators should be reported simply.
- Indicators should reflect both national and regional trends and allow for inter-regional comparisons. (We would add that there is a need for a parallel set of global and international indicators.)
- Indicators must have the flexibility to respond to new scientific information and public attitudes.
- A multidisciplinary approach which integrates environmental indicators with health and economic ones would be most useful in promoting an understanding of the inter-relationships between the environment and other sectors of society. This approach would include, among other things, a system of national accounts for the environment. (See the section of this paper entitled Policy Information Requirements for Sustainable Development and Theme Paper Three for a detailed discussion.)
- Indicators of risk and stress should be included with the measures of absolute quality. (See discussion of "critical loads" in the section entitled Prioritisation of Policy-maker Information Needs.)

Source: State of the Environment Reporting Branch, Corporate Policy Group, Environment Canada, Report No. 17, Environmental Indicators: Opinions of Potential Users (April 1990).

Identification of the policy decision-makers

Although this paper focuses on the information needs of policy-makers, there is nothing unique about the particular sorts of information required by those responsible for the formulation and administration of policy. The way in which they use information may distinguish policy-makers from other economic decision-makers, yet the same information is utilised by many different groups for a variety of purposes which may or may not be related to policy. In fact, one prerequisite for successful policy-making is the efficient dissemination of relevant information to all affected parties.

We thus categorize decision-makers broadly into two functional groups; those who are policy-makers and those who are not. The two are distinguished by the way in which they use economic and environmental information. Table 2(a) below gives an outline of the functions and information needs of both types of decision-makers in the policy context.

Table 2(b) gives a more detailed overview of specific issues and the types of environmental information needed by the groups identified.

It is clear from Table 2(b) that while the perspectives and uses of information will differ for different users, the actual information needed is very similar. Almost without exception, the same information is employed by all types of decision-makers. In order to set appropriate targets for environmental quality, policy-makers must have base indicators as well as data for monitoring changes over time. If the policy-maker is an elected body, knowledge of public opinion is an important aspect of its information needs (for more detail, see section entitled Decision-makers' Roles in Responding to and Initiating Policy Development).

Among the factors influencing corporate policy are compliance with government regulation and concern for corporate citizenship. Thus, the information needs of business will be similar to those of governments and supra-national agencies. In addition, compliance will require clear policy guidelines (e.g., mechanisms for limitations on emissions, safety regulations, monitoring and enforcement mechanisms); that is, the clear communication of what is intended by a particular policy and what is required of business in its role of policy recipient.

Table 2(a)
Categorization of Economic Decision-makers

Decision-maker	Function	Uses of PMI
Government (national, local — politicians, civil servants, advisers)	Policy-maker	Policy formulation/ administration
Other national and supra-national agencies (federal-style agencies, bilateral/multilateral lenders, commissions, etc.)	Policy-maker	Policy formulation/ administration
Business	Policy-maker	Policy formulation/ administration
	Policy recipient	Compliance
Consumers/citizens	Policy recipient	Compliance Statutory rights

Table 2(b)
Environmental Information Needs of Decision-makers

	POLICY-MAKERS			POLICY RECIPIENTS	
	Government		Supra-national		Citizens/
Issue	Local	National	Agencies	Business	Consumers
State of the environment	•	•	•	•	•
Environmental trends	•	•	•	•	•
How important is the issue? (according to)					
Public opinion	•	•	•	•	•
Expert opinion	•	•	•	•	•
Economic cost (cost-benefit)	•	•	•	•	-
Health impacts	•	•	•	•	•
How effective is policy?	•	•	•	•	•
What policies might be used by:					
National government	•	-	•	•	•
Business	•	•	•	•	•

Citizens/consumers need to know environmental trends. As consumers, they are interested in monitoring business policy on the environment. As citizens, they want to be aware of government policy, particularly as it affects their statutory rights and obligations. For instance, citizens may wish to be informed as to their rights of redress for damages suffered as a consequence of exposure to toxic substances following an industrial accident. Similarly, they will need to be informed as to changes in regulation regarding refuse disposal, collection and recycling of household waste.

Whereas the needs of different decision-makers for certain types of information are similar, their needs differ with respect to the form in which information is presented, as well as its timeliness. Scientific information that is readily understood by technical experts may need to be translated into terms that lay people can comprehend. Timeliness and accessibility may be of particular concern to businesses concerned with compliance, given the penalties that may be attached to non-compliance. In countries where the regulatory stance tends to be one of co-operation and assistance, much information (e.g., detailed guidelines on the nature of the regulation, requirements with respect to monitoring) can be obtained from the regulatory authority itself. However, one survey of United States business attitudes towards environmental information suggested that federal government information was often not up to date and that it lacked an international dimension (e.g., data on environmental requirements in countries other than the United States where business planned to operate)[1]. The report recommended the establishment of a central clearing-house for environmental information.

These issues — the availability of environmental information and the efficiency with which it is disseminated — warrant consideration from the perspectives of both the sources and the channels. It is generally assumed that governments produce and disseminate environmental information. However, if that information does not meet private-sector needs, one may ask why the market does not get involved in producing environmental information. And, to a certain extent, it

does — for example, through the many environmental data agencies that extract information for business.[2] In general, however, a great deal of information is collected to meet governments' monitoring and policy needs. Private agencies cannot generate such data, since (a) it is often released only because governments require its release, (b) the set-up costs of acquisition can be substantial, and (c) the cost of "patenting" information sources to prevent free duplication is often difficult. Thus, policy-makers, public and private, are generally forced to rely on governments to generate information. In fact, the concept of a central clearing-house is a familiar one in Europe where the proposed European Environmental Agency will have precisely this function. This is particularly relevant as the establishment of the single European market approaches. As businesses operate without border controls, environmental information relating to each European Community (EC) country will be required on an extended scale. Moreover, governments will require data that are comparable in order to monitor comparative compliance with federal-style environmental legislation and to make relative assessments of environmental achievements.

Compliance aside, business requires environmental information in order to monitor its own environmental achievements. This is important in an age when being "green" matters in terms of both market share and corporate commitment. Typically, "environmental audits" will be self-generated (i.e., the information on such issues as materials usage and energy consumption will come from within the company). However, various indicators (e.g., feasible target levels for energy efficiency, the costs and benefits of recycling materials, market prices for recycled products) will also come from more centralized sources. The contribution of the business world to information on more global concerns (e.g., CO2 emissions) is also likely to require at least some input from external sources.

Our conclusion is that the types of information required by different decision-makers are unlikely to vary widely. At bottom, everyone needs to know whether or not an environmental trend is significant, what its causes are, and what would be the costs and benefits of efficient policy measures. But whereas the nature of the information required may not vary much, what may matter most to business is the timeliness of the information, particularly when the issue is one of compliance with regulation. Moreover, the centralization of information brings obvious economies of access to all users, provided users can be satisfied as to reliability. Whereas the market-place can be expected to — and, indeed, does — provide considerable information, it will inevitably fall to governments to act as central providers of data.

Overview of policy-maker information

Policy-makers need information that is guided by:

- a clear understanding of the goal of sustainable development, that is, what the policy-maker is trying to achieve (see section entitled Sustainable Development);

- an analytical structure based on the pressure-environmental state-response model used in the Organization for Economic Co-operation and Development (OECD) approach. This model shows the sources of pressure on the environment, the resulting state of the environment, the consequences of that state in terms of impact indicators, and the potential cost-effectiveness of policy measures (see Table 3);

- efficiency of information: within the hierarchy of decision-making, whereas substantive presentations can be made to those in the lower echelons, progressively briefer and more concise presentations need to be made to those at the top;

- reliability of information: much of the information available is unreliable. This is especially true of environmental information, not only because of current limits to scientific knowledge but also because of poor analysis; and

- indicators of who gains and who loses from environmental change (the question of distribution, or equity).

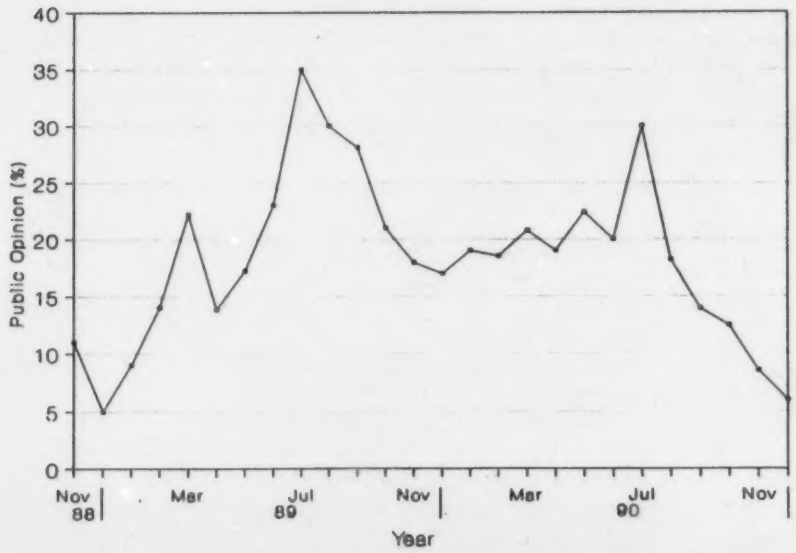
Decision-Makers' Roles in Responding to and Initiating Policy Development

Decision-makers not only respond to the environmental concerns of the public, expert scientific bodies and pressure groups, but they initiate environmental action, regardless of "extreme" opinion. Therefore, decision-makers should have ready access to an indication of opinion about a) general environmental concerns, b) rankings of concerns regarding different environmental issues, and c) broader social welfare and/or environmental policy objectives (see Figure 1 and Table 4).

Table 3
The Analytic Structure of Policy-maker Information

Pressure	State of the environment	Socio-economic consequences	The policy response
What is the source of the environmental problem?	What indicators of environmental change are available? How do they link to pressures and effects?	What indicators of effect exist?	How effective is policy?
Examples: population growth, subbsidies and underpricing, insecure tenure, protection	Example: OECD, *Environmental Indicators*, Paris, 1991	Example: Health,GNP loss, social cost, EIC	Examples: Policy analysis, cost-benefit analysis, cost-effectiveness

Figure 1
Public Opinion About the Environment
(UK) 1988-1990



The vertical axis shows the percentage of opinion poll respondents stating that the environment is a major problem in the UK. The high ranking of environment in the UK appears to commence after Prime Minister Thatcher's Royal Society speech in late 1988. It peaks in the summer of 1989 with the European Parliament elections and again at the time of the London ozone conference in June 1990. It falls away in August 1990, when Iraq invades Kuwait and security becomes top priority in the responses.

Source: MORI

Table 4
Expert and Public Risk Assessment in the USA and a UK Public Concern Comparison

EPA Scientific Advisory Board Unranked priority risks	USA Roper Public Opinion Poll March 1990	UK DOE/NOP Poll May 1989
"Ecological risks"	% saying problem very serious	% "very worried" about problem
Climate change	48	44
Ozone layer	60	56
Habitat change	42 (wetlands)	45
Biodiversity loss	nc	45
"Health risks"		
Criteria air pollutants	56	34 (fumes and smoke) 40 (acid rain)
Toxic air pollutants	50 (vehicles)	33 (vehicles)
Radon	17	—
Indoor air pollution	22	—
Drinking water	46	41
Chemicals (occupational)	63	—
Pesticides	52	46
Ozone layer	60	56

Issue regarded as important* by public but not by USA experts

United States	Active and abandoned hazardous waste sites	67%, 65%
	Industrial water pollution	63%
	Oil spills	60%
	Nuclear plant accidents	60%
	Industrial pollution accidents	58%
	Radioactive waste	58%
	Leaking underground storage tanks	54%
United Kingdom	Chemicals into rivers and sea	64%
	Sewage contamination of bathing water	59%
	Radioactive waste	58%
	Oil spills	53%

* over 55% in USA, over 50% in UK

Source: UK Department of the Environment/National Opinion Poll and "Counting on Science at EPA," Science, Vol. 240, 10 August 1990.

Opinion- and decision-makers' "responsive" mode

Opinion is a useful indicator of importance, which is relevant to decision-makers mainly in their "responsive" mode. In general, the channels through which constituents' opinions are made known to policy-makers are locally determined. The extent to which, and the means whereby, such opinion is incorporated into policy depends, among other things, on its consistency with the policy-maker's broader objective.

Information needs for initiating policy development

In terms of initiating environmental action and policy, decision-makers need information on the human, social and economic costs of environmental degradation. Four types of information merit consideration:

- measures of sectoral and national social cost;
- measures of "modified" gross national product (GNP) and/or satellite accounts (see Theme Paper Three for in-depth discussion);
- "impact" indicators (e.g., health); and
- indicators of "incidence" (who gains and who loses, or the "distributional" implications of policy).

Social cost of environmental damage

A number of attempts have been made to assess the social cost of environmental damage in monetary terms. Decision-makers require such information in order to gauge the importance of environmental damage generally, or of a specific environmental issue. Valuation procedures are well developed, even though they are controversial in some cases. Most valuation is based on "dose-response" studies (e.g., soil erosion causes a loss in crop output, which has a market value; air pollution damages buildings which have to be repaired earlier or more frequently than would otherwise be the case; health impairment leads to lost productivity, and so on).[4]

Table 5 provides an overview of various estimates. The illustrations are designed to show that, while there are obvious margins of error in the estimates, social cost assessments are feasible for both industrialized and developing countries.

Why are social cost estimates an important component of policy-maker information? The answer depends partly on who the policy-maker is. Environmental management is pervasive to government policy: energy sector planning has environmental impacts, as have, for example, transport, housing, agriculture and regional policy. Most importantly, the management of the economy has

Table 5
Summary of the Social Costs of Environmental Degradation in the Industrialized and Developing Worlds

Country	Nature of Damage	Year	% of GNP
Netherlands	Some pollution damage	1986	0.5-0.8
Germany	Most pollution damage	1983/1985	4.6-4.9
USA	Avoided damage due to environmental legislation	1978	1.2
Mali	Soil erosion	1988	0.4
Burkina Faso	Biomass loss	1988	8.8
Ethiopia	Deforestation	1983	6.0-9.0
Indonesia	Deforestation	1984	3.6
Indonesia	Soil erosion	1984	0.4
Poland	Pollution damage	1987	4.7-7.7

Source: D.W. Pearce and J. Warford. Environment and Development: Natural Resources in the Developing World. (forthcoming, 1991).

environmental impacts. Although in a number of countries this message is widely — though not comprehensively — understood, in many others it remains an unappreciated fact. This is largely because economic decision-makers are unaware that environmental degradation has a direct economic cost (in terms of foregone business activity and GNP) as well as an indirect economic cost in terms of sacrificed human welfare.

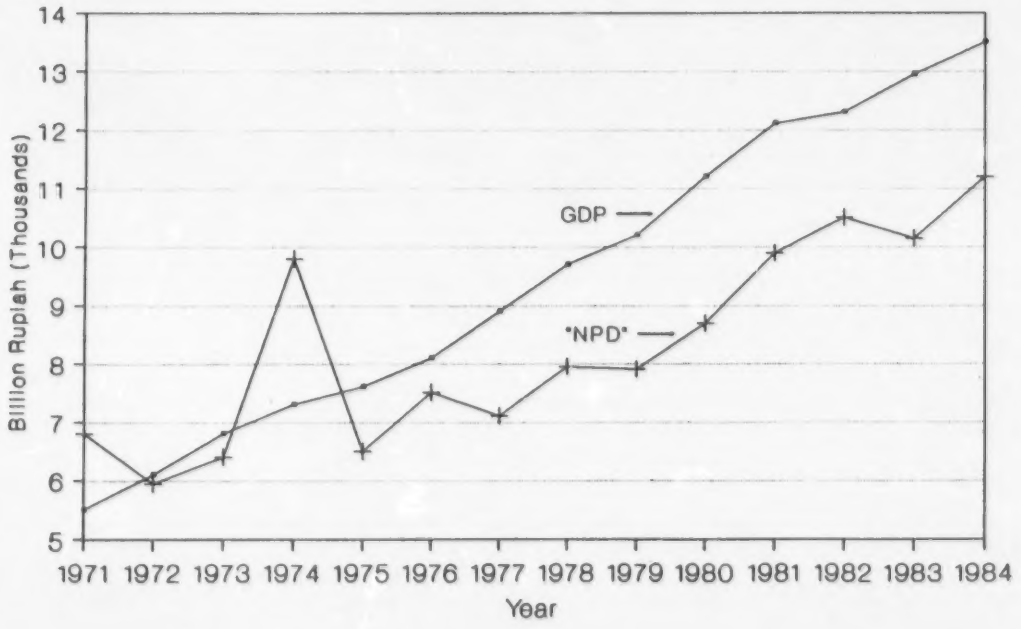
Thus, the management of the economy must be seen not only in terms of narrowly defined "economic" objectives, but also in terms of its indirect impact on the environment. For example, agricultural subsidies and price supports encourage intensive farming, and hence slurry and silage pollution, nitrate run-off and hedgerow removal. Social cost estimates are important in that they serve to "translate" environmental degradation into terms that finance ministers, the business community and others can relate to.

Modified GNP and satellite accounts

Policy-makers make extensive use of measures of economic activity, such as the GNP. It is now widely acknowledged that such measures, while suitable as indicators of economic activity, are deficient as measures of human welfare.[5] However, there is not yet a consensus on how GNP should be modified.[6] It is clear that pollution damage measured in terms of social cost (see above) should be deducted from GNP, and that there should be some form of depreciation on "natural capital." Figure 2 shows a modified GNP estimate for Indonesia. Theme Paper Three discusses the concept of a modified GNP in more detail.

Figure 2
"Modified" GNP for Indonesia

GDP and "NDP," in constant 1973 rupiah



The diagram shows GNP in conventional terms. "NDP" is "net" domestic product and is obtained by deducting from GNP:

- extracted timber value
- value of oil extracted
- soil erosion losses

Source: R. Repetto et al. Wasting Assets. World Resources Institute, Washington, DC (1988).

The "physical" approach, first set up by Norway in 1974 and since adopted by France, Canada and the United Nations Environment Programme (UNEP), involves the use of what have become known as satellite accounts. These are non-monetary accounts which parallel GNP figures in monitoring the state of the environment and stocks of natural resources. Such systems generally require a classification of natural capital, with periodic re-evaluation when earlier estimates are revised (e.g., when existing mineral reserves are extracted and new ones are discovered and/or developed). Results of the system have been mixed. The accounts appear to provide useful information on the state and use of natural resources, but their usefulness to planning and policy analysis has yet to be demonstrated. In Norway, the most successful application has been in the preparation of a set of energy accounts from which energy demand and emissions of major air pollutants (the outcome of the chosen energy mix) are forecast.

Impact indicators

Environmental indicators, which are closely related to the social cost of environmental damage, are the basis for relating environmental statistics to socio-economic statistics. The OECD approach mentioned earlier is useful in assessing the impact of various pressures on environmental systems and the policies devised to alleviate such pressures. If we can identify levels of pressure/environmental stress associated with social costs, then we will be in a position to develop policy benchmarks and targets as well a means of monitoring the impact of particular policies. (For a discussion of critical loads, see section entitled Prioritisation of Policy-maker Information Needs.)

Take a simplified example, that of the health implications of atmospheric pollution. Ambient air quality and exposure of a population to pollution must reach a certain level before widespread detrimental health effects become evident. If this level is known, and an estimation of associated costs of lost productivity and increased provision of health care can be made, then we have the ability to determine the cost, in monetary terms, of the impact of given levels of pollution on the health of the population. The focus of policy aimed at reducing the costs of morbidity due to air pollution may then be on achieving specific levels of ambient air quality, air quality with respect to economic activity, and/or exposure of the population to toxins.

Indicators of incidence

One implication of policies aimed at the environment is that (as with any public policy) there will be some members of society who will benefit more than others. These distributional considerations are a matter of policy prioritisation and practicability. For example, the policy position embodied in the "Polluter Pays Principle" (PPP) is that the costs of using the environment's waste assimilative capacity should be borne by the commercial producers of waste and their customers; the former through emissions charges, permits, fines or other levies designed to encourage abatement or finance clean-up, and the latter via the price system, which passes the producer's increased costs on to the customer. In contrast to the unregulated case, society at large does not bear the cost of environmental degradation (e.g., by having to bear the health effects and/or finance clean-up).

Sustainable Development

Introduction

The way in which policy-makers define sustainable development will determine requirements for policy-maker information. It is the need to achieve sustainable development, however it is defined, that must guide the form and content of policy-maker information. Definitions of sustainable development abound. Because the term has value connotations, definitions frequently reflect the personal objectives of those who define it. Despite the multiplicity of meanings ascribed to sustainable development, decision-makers need some broad consensus on its meaning in order to establish their likely demands for information. As an example, if "sustainable income" is to be seen as an appropriate measure of sustainable development, then decision-makers will need indicators of sustainable income (i.e., an appropriately modified GNP). This chapter outlines the economic and the ecological approaches to defining sustainable development, and suggests how the two may be reconciled from the policy-maker's standpoint.

Economic Approaches to Defining Sustainable Development

Introduction: capital, depreciation, investment and sustainability

The Brundtland Commission defined sustainable development as:

". . . development that meets the needs of the present without compromising the ability of the future generations to meet their own needs."[8]

According to this definition, sustainable development is about being fair to the future. Everyone is familiar with the idea of living off capital, and with the caution that it is possible to do so only temporarily. If we are to sustain our livelihoods — that is, maintain a reliable source of income — we must put income aside to cover the depreciation of the productive assets upon which we rely for that income. Nations are no different. In calculating a nation's wealth and income, we do indeed make some estimate of the depreciation of our infrastructure, machinery and factories. What we should always be looking at is net income and not gross income. The difference between gross and net income provides a first clue as to the meaning of sustainable development. No nation can say its economic activity is sustainable if it fails to replace capital that is depreciating. Similarly, no nation will expand its future income unless it invests in new capital. The first requirement for sustainable development, therefore, is that a nation's investment be sufficient both to replace depreciated capital and to create new capital.

Therefore, national accounting systems must not only incorporate the notion of capital depreciation, but also include an improved indication of human well-being, since this is the ultimate objective of sustainable development. An index of human development such as the one produced by the United Nations Development Programme (UNDP) would enable a definition of sustainable development to be formulated fairly simply (see section entitled Policy Information Requirements for Sustainable Development). We could say that a nation is developing sustainably if its human development index has risen systematically over time, allowing, perhaps, for a limited number of short-term deviations.

But how does a policy-maker know if he or she is on the path toward sustainable development? Simple extrapolation from past trends is inappropriate, since trends may change. Rather, the answer lies in the notion of capital depreciation.

The components of a human development index reflect different types of capital. Capital which supports and generates income is man-made capital — for example, machines and roads, factories and vehicles. Human health and education are elements of what the economist calls human capital. That is, we need to think of the skills and capabilities of individuals as forms of capital, just like machinery. We need to invest in that capital through education and through health care and preventive medicine. If both man-made and human capital begin to decline, this means we are not on a path toward sustainable development. The result accords with the layperson's perception that a nation can ill afford to run down neither its education, research and health sectors, nor its technology and man-made capital. We must keep capital intact.

Broadly speaking, the basic rule of sustainability — that is, bequeathing either the same resource endowment we received, or an improved one, to the future — can be interpreted in two ways. The first, outlined above, requires the maintenance of man-made and human capital through ongoing investment in areas that allow society to maintain a productive sector, both with respect to industrial infrastructure and work force. The second is found in the notion of environmental or natural capital (the stock of natural assets, such as tropical forests, freshwater, fisheries and wildlife). To think of other environments as wealth, too, is not such a familiar notion. For example, the ozone layer is an environmental asset, as are the fundamental biogeochemical cycles that regulate the earth and life upon it.

The broad interpretation of sustainability

On the economic interpretation of sustainability (as fairness to the future) it is the total stock of all forms of wealth that must not be depleted. It is consistent with this view that environmental wealth is depleted as long as that depletion is compensated for by building up the other forms of wealth, that is, human and capital wealth. Equally, if man-made wealth is run down, environmental capital must be built up to compensate. In this broad view of sustainability, the two basic forms of capital — man-made and natural — are substitutes for one another. Thus, deciding how much of each form of capital to have depends on the values placed on them by society. If it is more important to clear tropical forest for agriculture or timber, then the broad interpretation of sustainability sanctions that process.

Sustainability as conservation of natural resources

The broad interpretation of sustainable development allows for the running down of environmental wealth as long as man-made capital is substituted for it, and as long as the "trade-off" is fully informed in terms of the right prices for the two forms of capital. But the sustainable development debate has tended to place even more importance on the environment than is supported by this

broad view. What are the arguments in favour of conserving natural assets so as to leave the next generation with an environment similar to ours? They rest largely on the nature of environmental assets, their function in human use, and the state of scientific knowledge. The reasoning is summarized below, in the discussion of the issues of non-substitutability, irreversibility and uncertainty.

Non-substitutability

Many environmental assets do not have man-made substitutes. For example, we cannot feasibly plug the hole in the ozone layer, nor substitute readily for the carbon cycle. The fact that environmental capital has a quality of non-substitutability should make us even more cautious about running it down.

Irreversibility

A further variation on non-substitutability is that we cannot replace an extinct species. A great deal of environmental capital has the quality of being irreversible: once lost, it cannot be regained. This is in contrast to man-made capital, which can be destroyed and rebuilt almost at will. Some people argue that although we cannot substitute for the rhinoceros or the elephant, we can create some good that will give us equal pleasure. This "substitution of well-being" argument overlooks the fact that "well-being," or, in the economist's language, "utility" is not homogeneous. There are experiences which, for many people, are unique and for which there no substitutes — the music of a great composer, the writing of a Shakespeare, the wonder of a rainforest.

Uncertainty

Finally, we do not fully comprehend how natural environments function and what services they provide. In the face of such uncertainty, it seems dangerously risky to behave as if we know what we are surrendering by degrading our environment further.

Ecological Approaches to Sustainable Development

The economic approach to sustainable development tends to focus on output, since output contributes directly to human well-being, or "utility." Maintaining overall capital (broad definition) or natural capital (narrow definition) then becomes a condition of sustainable development. The ecological approach, on the one hand, tends to focus on inputs, that is, on the quantity and nature of resources needed to sustain output. This approach has a close affinity to the narrow economic approach (constant or increasing natural capital), but not to the broad approach, which would allow continuous reductions in ecological capital.

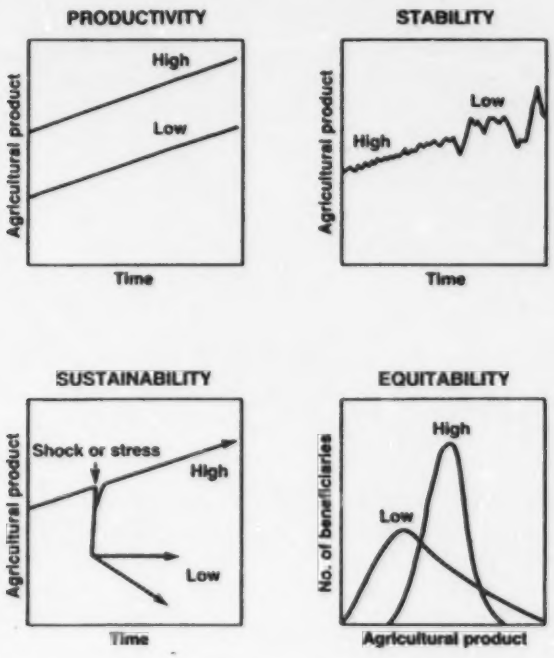
One good example is fertilizer. Nature applies its own fertilizer to the soil in the form of biomass waste and animal waste combined with natural microbial processes. Artificial fertilizers are extensively used, both as a substitute for natural fertilizer and as a means of extending the limits of supply of the natural source. However, both processes risk environmental degradation through loss of soil "body" and fertilizer run-off, as well as posing ecological risks, through the imposition of stress on ecosystems.

Conway (1987) has characterized the situation well — Figure 3 shows his depiction of the ecological approach to sustainability. Ecosystems are characterized by productivity (high and low outputs), stability (variance about a trend), equitability (i.e., the incidence of benefits), and sustainability (resilience to shock or stress).

Reconciling the economic and ecological approaches

The following brief discussion raises the possibility that the economic and ecological definitions of sustainability are consistent with one another. Essentially, sustainable development is defined in terms of some development indicator (e.g., GNP, "modified GNP," or an indicator of social progress) which rises through time, or at least remains constant. To secure an acceptable degree of confidence that there will be sustained development in the future, it is necessary to ensure that the overall resource endowment does not decline. Effectively, every generation has the same productive opportunity, or more, than the preceding one. While this condition is consistent with the concept of running down environmental assets provided that other forms of capital are substituted, it is inconsistent with the ecological approach to sustainable development, which stresses the conservation of natural capital. Consistency can be re-established by observing that the ecological definition effectively denies that different forms of capital are readily substitutable. Not only does substitution risk further environmental damage (e.g., nitrogen fertilizer risks nitrate contamination), but it also raises the stress level of the receiving ecosystems.

Figure 3
Indicators of Agricultural Performance



Source: G.R. Conway, Helping Poor Farmers — a Review of Foundation Activities in Farming Systems and Agro-ecosystems Research and Development. New York, Ford Foundation (1987).

The end result, of course, cannot be any absolutist rule about conservation or development. We cannot, for example, say there should be no nitrogen fertilizers; rather, we need to seek some form of balance, particularly with respect to protecting "critical" and "fragile" ecosystems where small perturbations can give rise to major stress (e.g., coral reefs, many drylands, some tropical forests).

The Informational Implications of Sustainable Development

The preceding discussion may appear remote from "policy-maker needs," but it is, in fact, important. If we have no coherent concept of the meaning of sustainable development, we can offer no meaningful guidance on information needs. In other words, if we don't know what we are aiming for, we cannot say what we need to know.

Thus, we follow on from the preceding discussion with some broad indicators of the information-related needs that arise from the two approaches to sustainable development:

- Indicators must show the stock of environmental assets (where possible), as well as rates of use, rates of waste generation and rates of regeneration of the asset;
- Indicators of ecosystem stress should be developed. The OECD's initial programme of indicators provides some appropriate measures. For example, water extraction rates relative to water regeneration rates offer a guide to pressures on the water environment.
- Indicators of the cost of rehabilitation, environmental regulation, etc., can be seen as measures of environmental scarcity. The basic idea is that rising costs (e.g., pollution abatement costs as a percentage of gross domestic product (GDP)) may reflect not only rising environmental standards, but also rising unit costs of control as economic and population growth increasingly impinge on natural environments. Rising costs may also be associated with increasing marginal costs of abatement, possibly associated with falling marginal environmental benefits. From the standpoint of policy efficiency, the source of rising

costs needs to be known. At present, few satisfactory indicators of comparative environmental protection costs appear to be available.

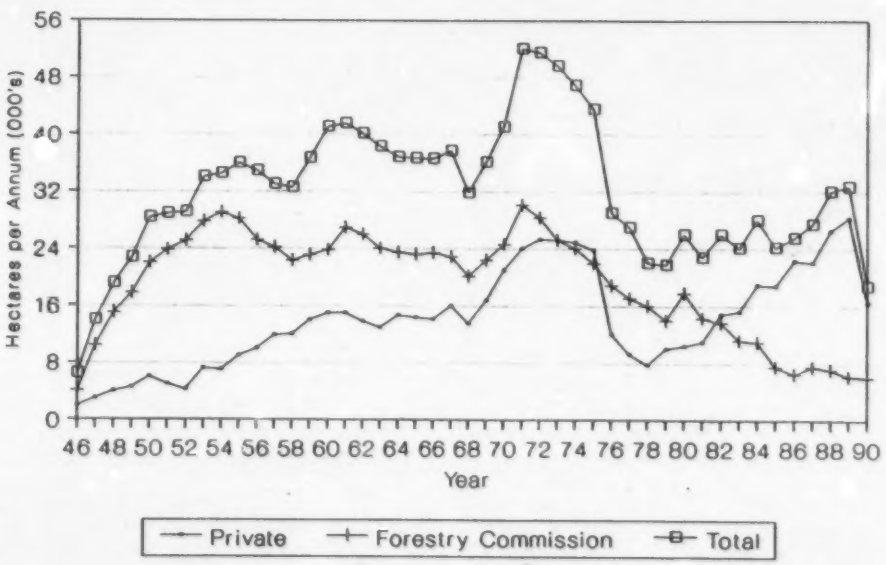
- Ideally, monetary valuation of any net depreciation of assets (rate of use less rate of regeneration) should be shown alongside figures for GNP.

Some case material illustrates the first three points above. The last point has already been referred to as an objective for the longer term. In addition, it is not clear to us that policy-makers at the national level are, or will be, sensitive to estimates of "sustainable income."[9]

For the first point, let us examine the state of forests, harvests and rates of new planting in the United Kingdom. The UK practises "sustainable forestry" as far as individual plantations are concerned. It is also sustainable insofar as there are net additions to forested land each year. However, it may not be sustainable if depressed rates of new planting are maintained; that is, the existing stock could decline (see Figure 4). For the second point, we reproduce some data on water extraction rates for countries not covered in the OECD's work on indicators. Clearly, these data reveal very disturbing situations for some of the countries, where the water extraction rates are non-sustainable (see Figures 5(b)-(c)).

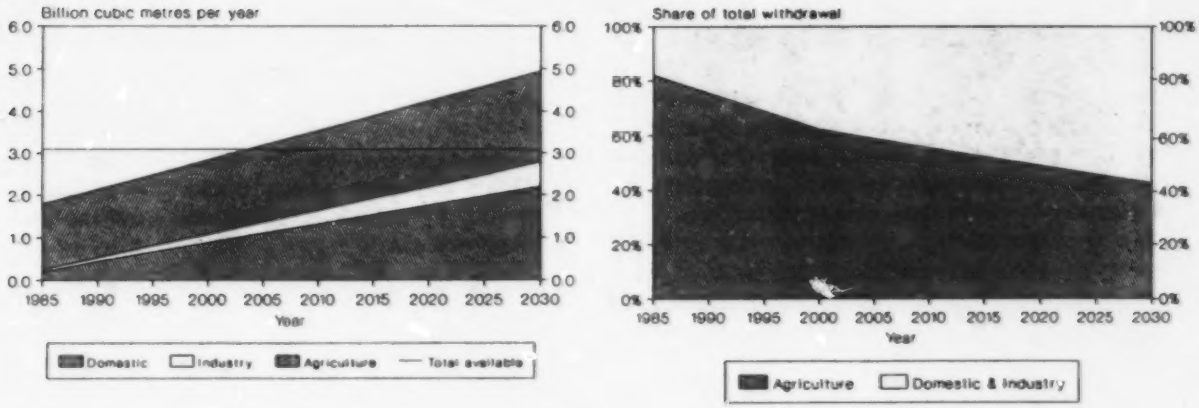
The third point is partially illustrated by some provisional OECD data. Expenditures on pollution abatement and control (PAC) typically average around 1.2% of GDP (see Figure 6).

Figure 4
Total New Planting of Trees for Timber (UK 1946-1990)



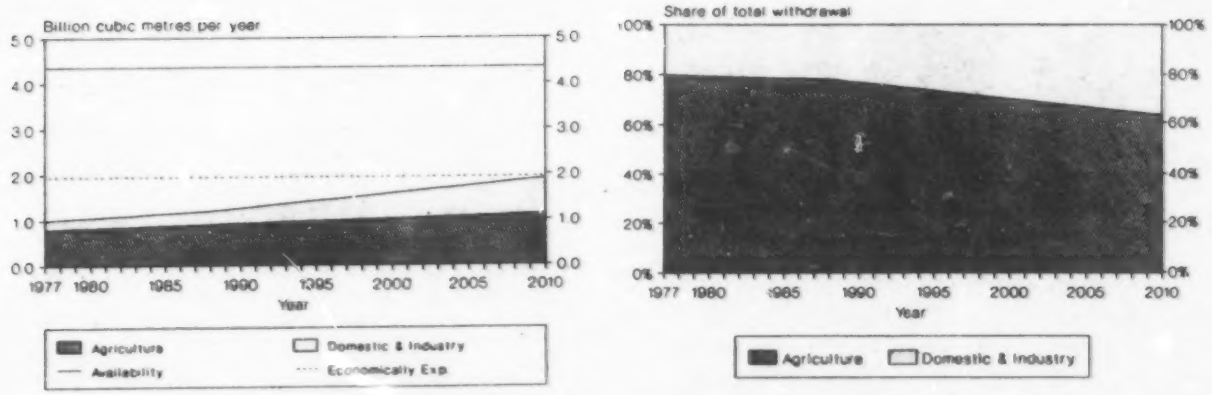
Source: Authors' estimates based on Forestry Industry Committee of Great Britain Data.

Figure 5(a)
North Yemen: Water Availability and Withdrawal



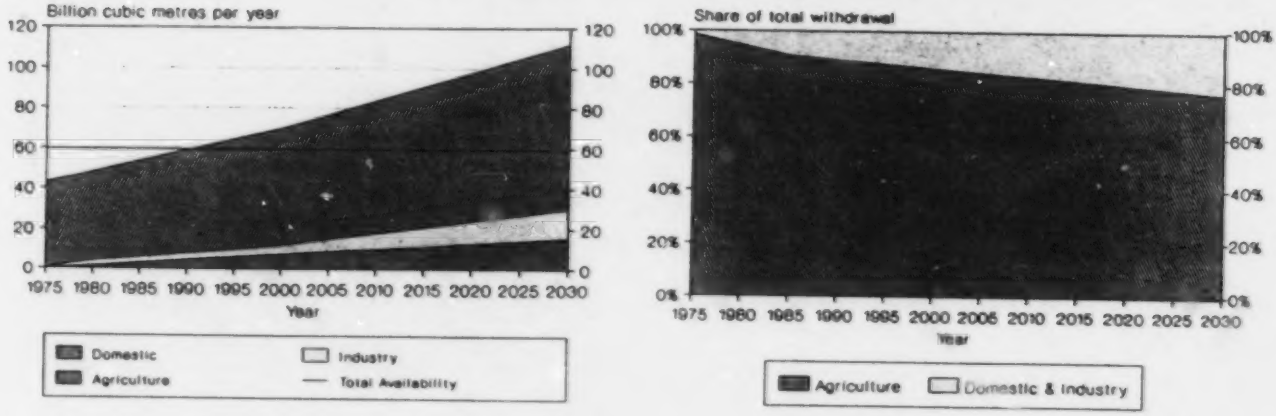
Source: Water International, 1989

Figure 5(b)
Tunisia: Water Availability and Withdrawal



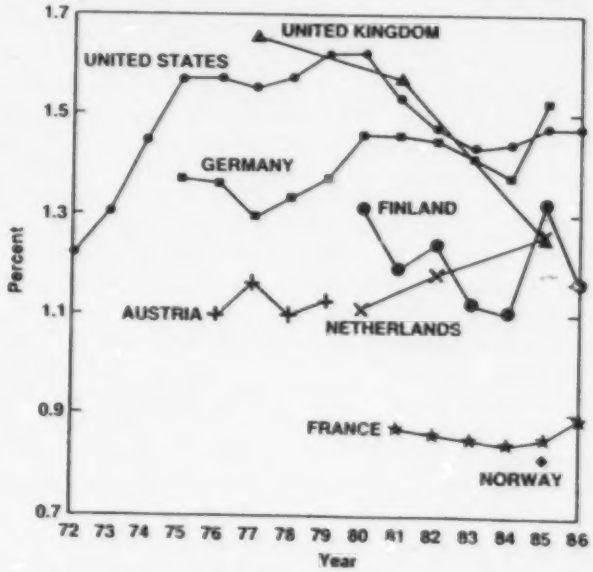
Source: Country Environmental Study, (World Bank). World Resources 1986.

Figure 5(c)
Egypt: Water Availability and Withdrawal



Sources: Water International, 1989. UNESCO (1975 data).

Figure 6
Public and Private Pollution Control Expenditures (percentage of GNP)



Note: Private household expenditures excluded

Evidence that these costs will rise comes from the Netherlands experience, where, under the National Environmental Policy Plan, abatement costs are expected to rise to between 3% and 4% of GNP.[10]

An economic study of air-pollution control expenditures in the U.S.A. suggests that expenditures (in 1985 US$) for the years indicated were:[11]

- 1975 $4.5 billion
- 1980 $13.7 billion
- 1985 $33.0 billion

Expressed as a proportion of GNP (also in 1985 US$), these expenditures are as follows:

- 1975 0.15%
- 1980 0.39%
- 1985 0.82%

The figures show a significantly rising financial burden through time.[12]

The Economic Implications of Sustainable Development

The preceding discussion suggests that several major steps of a practical nature need to be taken if sustainable development is to be achieved. Each action has major implications for the provision of information.

Changing the national accounting system

Already, a significant amount of effort is going into modifying the way in which we measure economic progress. At present, the basic indicator of economic progress is gross national product (GNP), which measures the aggregate value of the output in the economy in a given year. GNP ought to be related to society's well-being. If GNP goes up, we ought to be able to assume that well-being has improved. But GNP is misleading in this respect. Consider what happens if people spend money trying to adapt to or prevent pollution. Their expenditures appear as a contribution to GNP, and the environmental damage they seek to offset is not recorded at all. This is essentially the same point we made earlier: the fact that environments do not generally have markets does not mean they have no economic value. In that GNP essentially measures the value of marketed output, it ignores the environment.

Any environmental damage that occurs should be valued and deducted from GNP. National accounts statisticians are used to making reasoned estimates of the amount of depreciation of man-made capital. They deduct this depreciation from GNP to get the net national product (NNP). NNP is a better measure of well-being, because it allows for the fact that some of the wealth from which GNP flows is subject to decay and depreciation. But NNP ignores natural wealth, which is also subject to depreciation — for example, the running down of oil reserves or the reduction of the standing stock of forest. There is no logic to support including one form of depreciation and not the other.

These types of modifications to the accounting systems are beginning to be made, but they are complex and costly in practice. A feasible alternative is to publish a separate set of resource accounts which show, in non-monetary units, exactly what is happening to the resources in a given country. Such accounts exist in France and Norway. (See discussion in section entitled The Demand for Policy-maker Information.) More modest modifications can be made to sets of environmental statistics which, although published in most industrialized economies, are rare in the developing world. What is important is to show how changes in environmental variables are linked to changes in the economy. This at least avoids the error of managing the economy as if it were unrelated to the environment.

Correcting prices

Whether one adopts the broad or the narrow view of sustainability, the above discussion demonstrates that it is vital to ascribe the proper economic values to natural resources. To this end, two modifications are needed. First, the prices of natural resources should reflect their full value. The price of a resource is obviously linked to the cost of its extraction, or harvest, and the market mechanism ensures that such costs are reflected in prices. However, resource extraction and harvesting can also impose costs on others. For example, if timber is removed unselectively from a tropical forest, the watershed will be damaged as a result of river pollution and soil erosion. Yet these costs are not reflected in the price of timber. In effect, the market has "failed," because the timber price takes no account of the value of the natural environmental services it has used. We can say that prices should not just reflect the extraction and harvesting costs, but also the environmental costs.

There is one more adjustment to be made to resource prices. If a resource is harvested sustainably, its stock will remain broadly constant over time. If it is used unsustainably, its stock will be reduced and what is lost will not be available to the next generation. This lost future benefit resulting from unsustainable management is

called a user cost. Obviously, there must be a user cost involved in the extraction of any exhaustible resource. There is also a user cost attached to the non-sustainable use of a renewable resource.

With these considerations in mind, we have formulated a basic rule for the "proper" pricing of natural resources. The prices of natural resources should reflect their extraction costs plus environmental costs plus user costs.[13] While the informational implication of this is that the divergence between "proper" and "actual" resource prices needs to be measured, few official environmental publications list any price information.

An adjustment must also be made to commodity prices. Because the production of goods and services necessarily "uses up" environmental services that are treated as if they are free, those prices are not correct prices. The adjustment required is consistent with the "Polluter Pays Principle" (PPP) — i.e., making the polluter pay for the costs of environmental clean-up or for the environmental damage done in producing the good in question. This can be done by imposing a charge on the good, based on its pollution content. The charge will be partly passed on to the consumer in the form of higher prices. In practice, pollution charges are still rare: the main way of implementing the PPP is by making polluters pay the costs of regulation designed to achieve a given environmental standard. There are now signs, however, of charges being introduced. Once again, the informational implication is that indicators of "proper" and "actual" commodity prices need to be developed.

Project appraisal

The third modification required for the implementation of sustainable development practice is a change in the way we appraise investments. It is all too common to pay only lip service to the environment when deciding on development projects. The rules used by bilateral and multilateral agencies when lending to the developing world are a particularly good illustration of this. However, practice is changing slowly. The vital modifications needed have to do with measuring the environmental effects of projects and getting environmental values integrated into the economic appraisal. The techniques for doing so are fairly widely available, although a great deal of work still remains to be done in this area.

A further change is required. Even if the environmental effects of development projects are properly priced, such projects will inevitably degrade certain environmental assets. Because allowing such degradation is not compatible with holding the stock of environmental assets constant over time, the investment portfolio has to be altered to ensure that there are offsetting investments in the environment. These offsetting investments will not necessarily pass an orthodox project appraisal test. Their function is to compensate for the environmental losses incurred by other projects. The informational implication is that decision-makers need better data on the ecological impacts of investment projects and programmes.

Policy Information Requirements of Sustainable Development

Environmental Indicators

The OECD Environmental Indicators Programme uses a model context for determining the selection of environmental indicators. This model is based on "pressure-state-response," the basic idea being that indicators need to reflect:

- pressures on the environment (e.g., population change, economic growth, structural change, "wrong" pricing, public concern);
- the state of the environment itself (e.g., trends in emissions of air pollutants, ambient pollution concentrations, amounts and nature of waste disposed of);
- the response of society in terms of government policies, ameliorative measures undertaken by individuals and businesses, social response in terms of environmental activism, etc.

Figure 7 shows one such model of indicators.

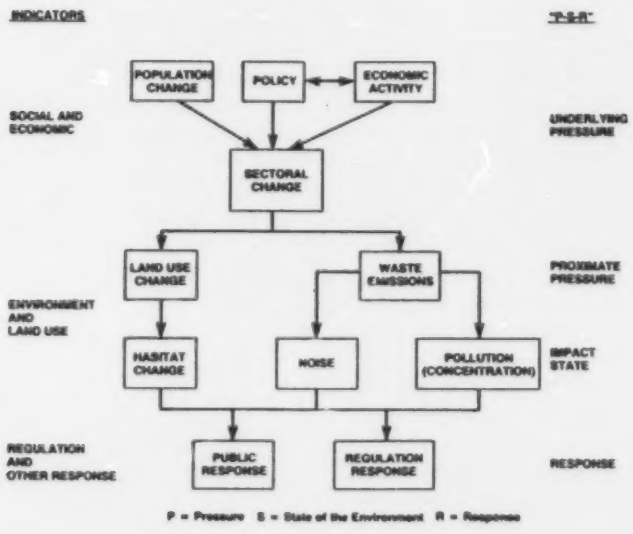
In the following sections, we distinguish several types of indicators which fit into this model.

Environmental efficiency indicators

These are broad magnitudes that link environmental measures to economic activity. Thus, a measure linking energy consumption to GDP would be a surrogate for an environmental efficiency measure of energy use. Energy production and use have well known environmental impacts. Table 6 illustrates these effects for various energy sources.

Any reduction in the amount of energy per unit of GDP is a reduction in environmental impact per unit of economic activity. The economy becomes more "environmentally

Figure 7
A Basic Model of Environmental Indicators



Source: D.W. Pearce, R.K. Turner et al. "The Development of Environmental Indicators." Report to the UK Department of the Environment, University College London, February 1991.

efficient" because it becomes more energy efficient. Note, however, that this measure of efficiency is consistent with an increase in the absolute level of environmental impact. This is because gains in efficiency can be outweighed by the absolute growth of GNP. An improvement of 10% in energy efficiency, for example, could be associated with an increase in energy-related emissions if energy demand grows by more than 10%.

Environmental efficiency measures the extent to which the underlying change in the economy reveals "decoupling" of economic activity and environmental impact. Efficiency gains may come about "naturally" — that is, as a result of the evolution of the economy — or as a result of deliberate policy measures (environmental regulation, for example). Since disentangling the sources of efficiency gain can be complex, policy decision-makers need guidance on such a decomposition of causal factors. Note that this type of information is needed, whether the decision-maker is from industry or from government. If industry is under pressure to "be green" or has a corporate commitment to being green, it will need the same kind of structured analysis of indicators that government does. Basically, any analysis should indicate:

- directions of change in efficiency (will it continue or not?);
- the broad extent to which efficiency has been brought about by policy at home or abroad;
- some comparative assessment — for example, by reference to the achievements of other companies or other countries.

Figure 8 shows one illustration of such an indicator with respect to sulphur dioxide reductions in Europe.

Table 6
Selected Environmental Effects of the Energy Sector

Energy Sources	Air	Waters (surface, underground/ inland and marine)	Land and Soils	Wildlife	Others (solid waste, risks, human health, noise, visual)
Fossil fuels: extraction, treatment, transport, waste, disposal					
Coal	• SO_X, NO_X particulates	• Acid mine drainage • Mine liquid waste disposal • Water availability • Wash water treatment • Water pollution from storage heaps	• Land subsidence • Land use for mines and heaps • Land reclamation of open cast mines	• Natural habitat disturbed • Exploitation of wilderness or natural areas for surface mining	• Noise of rail transport of coal • Dust emission • Visual impact of coal heaps • Occupational risks
Petroleum Products	• H_2S production • SO_X, NO_X, CO, CO_2, HC, ammonia, particulates, trace elements	• Oil spills • Water availability	• Land use for facilities and pipes	• Natural habitat disturbed • Pipeline impact on wildlife • Wildlife polluted through leaks or spills	• Blow-outs • Explosions and fires • Odour • Pipeline leaks • Spills (accidental and operational) • Visual impacts of pipelines
Gas	• HC emissions (mainly methane) • Trace metal emission • H_2S and combustion emissions	• Liquid residual disposal	• Land use for facilities and pipes	• Natural habitat disturbed • Impacts of pipelines on wildlife	• Blow-outs • High leak potential • General safety • Spills and explosions • Visual impacts of pipelines

Table 6 (cont'd)
Selected Environmental Effects of the Energy Sector

Energy Sources	Air	Waters (surface, underground/ inland and marine)	Land and Soils	Wildlife	Others (solid waste, risks, human health, noise, visual)
Renewable energy					
Hydropower		• Effect on hydrological cycles • Water quality and resources	• Land irreversibly flooded • Landslide risks	• Wildlife habitat of rivers • Change in eco-systems • Fish migration effected	• Visual impacts • Risk of dam rupture
Others: biomass, geothermal, wind and solar energies	• Biomass combustion: air pollution, particulates • Geothermal: air pollution	• Biomass conversion: water pollution; water availability • Geothermal: water pollution	• Land use for energy plantations • Land requirement of solar energy	• Biomass: eco-system disruption by energy plantations	• Noise of wind generators • Visual impact of wind generators • Photovoltaic toxic pollution when decom-missioning
Electricity generation from fossil fuels (excluding nuclear energy)	• SO_x, NO_x, CO, CO_2, HC, trace elements, particulates, radionuclides • Long-range transport and deposition of pollutants • Climatic impacts of cooling towers	• Water availability • Thermal releases	• Land requirement	• Secondary effects on water, air and land	• Visual impact of cooling towers and lines • Solid wastes • Ash disposal • Noise

Table 6 (cont'd)
Selected Environmental Effects of the Energy Sector

Energy Sources	Air	Waters (surface, underground/ inland and marine)	Land and Soils	Wildlife	Others (solid waste, risks, human health, noise, visual)
Uranium fuel cycle and electricity from nuclear power plants	• Radioactive dust • Gaseous effluent (radionuclides, F, NO_x) • Noble gas, H-3, I-131, C-14 • Local climatic impact of cooling towers	• Mine drainage • Underground water contamination • Water availability • Thermal releases • Liquid radionuclide emission (H-3, Co-60, Sr-90, I-131, Ru-106, Cs-136 and 137)	• Land subsidence (mines) • Land reclamation of open cast mines • Land use for mines	• Secondary effects of impacts on water, land and air	• Radioactive products • Mine water • Mill tailing water (toxic metal liquid and solid chemical wastes, radiological wastes) • Recycled fission products • High level radioactive wastes • Visual impact of cooling towers and power lines • Noise • Occupational risks
	• Decontamination and decommissioning of nuclear power plants				

Source: OECD. "The State of the Environment 1985," OECD, Paris, 1985.

Previously discussed measures of social cost, modified GNP and satellite accounts are all relevant to the issue of environmental efficiency. Thus, expressing social cost as a proportion of GNP would permit international comparison if the measures were of broadly the same type of social cost. The chances of achieving such comparability are probably small at the moment. More usefully, measures of social cost over time for a single nation would indicate whether the economy is more or less environmentally efficient. Daly and Cobb have computed such an index for the USA. Figure 9[14] shows the result, suggesting that per capita "sustainable welfare" in the USA actually began to fall in the mid-1970s. Space forbids a discussion of the Daly-Cobb index, and its reporting here should not be taken to imply that it is credible. The essential point is that, if credible, such a measure could be more than an indicator of human welfare. If the adjustments made to GNP could be disaggregated to show which were due to environmental deterioration and which were not, then the indicator could also be used as a measure of environmental efficiency.

Figure 8
European SOx Emissions and Percentage of Reduction Achievements

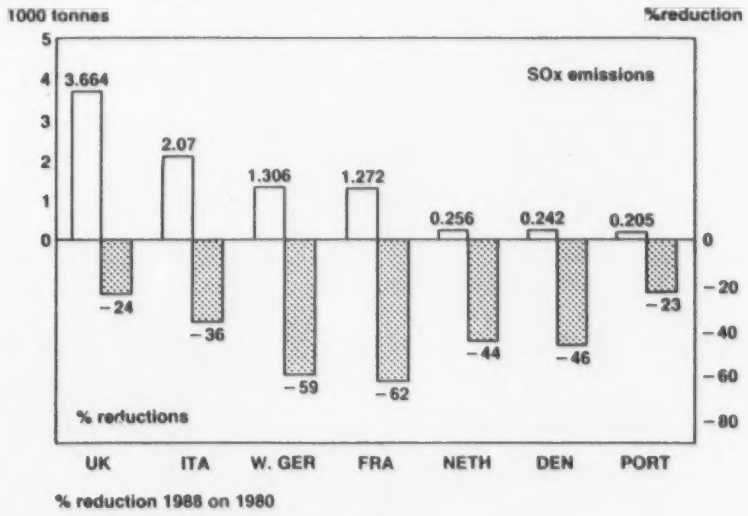
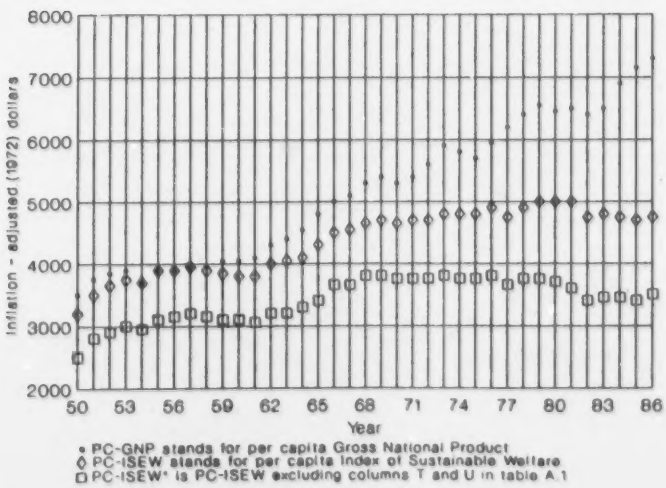


Figure 9
Alternative Measures of Economic Welfare


Inflation - adjusted (1972) dollars
Year
• PC-GNP stands for per capita Gross National Product
◊ PC-ISEW stands for per capita Index of Sustainable Welfare
□ PC-ISEW* is PC-ISEW excluding columns T and U in table A.1

Policy efficiency indicators

Policy efficiency indicators measure how successful actual policy has been in its environmental aims. Such measures could include indicators of the extent of compliance with a regulation. More usually, the relevant indicators are of physical form — emission reductions over time, ambient concentration changes, kilometres of river classified as "clean," and so on. But considerable caution is required when using such indicators. If emissions go down over time and the reduction coincides with, say, a Clean Air Act, it cannot be concluded that the reductions are a measure of the efficiency of policy. Statistical analysis is required, and this will frequently limit the communication between analyst and policy-maker. Simply put, not all policy-makers are equipped to understand the implications of principal components analysis, regression analysis, etc.

Some cases tend to be fairly clear. Figure 10 shows lead emissions in the UK together with standards set either in the UK or in the European Community. (The main EC Directive was in 1985). Clearly, lead intensity is closely linked to the standards set. In the last two years (1989, 1990), the reduction of emissions has been further accelerated by significant price differentials between leaded and unleaded gasoline.[15] However, other examples are far less clear-cut. Studies of the US Clean Air Act, for example, suggest that the Act may have been less important than other factors at work in the economy that reduced pollutant concentrations, namely, coal usage, total investment and product price.[16]

The general conclusion has to be that indicators of environmental policy efficiency are likely to be difficult to establish and will be open to differing interpretations. But understanding these linkages (from "response" back to "pressure" in the pressure-state-response mode) is critical to the design of efficient policy. Complexity is no excuse for not making the effort.

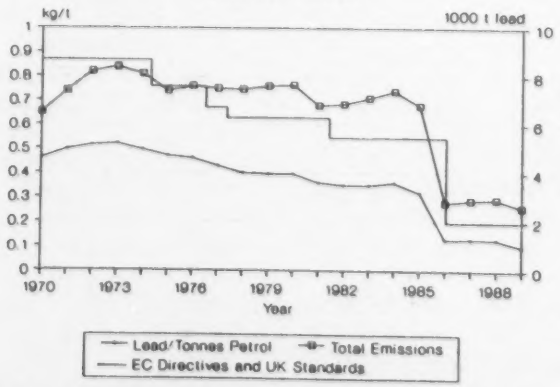
Measures of human development

"Development" is not the same as growth of income. It is a broader (and somewhat vague) concept that embraces some notion of equity between the members of a generation, some notion of basic freedoms and human rights and some notion of mental and spiritual welfare.

Finding a measure of development is problematic. Perhaps the closest we have come is the UNDP's human development index. The UNDP has observed that: "There is no automatic link between economic growth and human progress."[17] Its idea was to combine, in an ingenious way, a country's achievements in respect of literacy, life expectancy (a surrogate for health) and gross income (net income being very difficult to estimate for many countries). Table 7 shows a table comparing the top countries' rankings according to the human development index to their rankings by gross national income.

The exercise produces some surprises (e.g., the position of the USA). The implication is that the USA is less developed than Spain, Ireland, Italy or Belgium. Whatever the virtues of the human development index, it does at

Figure 10
Lead in Petrol



The diagram shows the decline in emissions, and in lead per tonne of petrol, against the various standards that were adopted. From 1970 to 1985, various pieces of scientific advice were given to the UK government regarding the role of blood lead in morbidity and mortality. Public pressure also came from international sources and from various campaigns.

Table 7
Country Rankings by Human Development Index and Gross National Income

Country	Human Development Index	GNP per capita
Japan	1	5
Sweden	2	6
Switzerland	3	1
Netherlands	4	14
Canada	5	7
Norway	6	3
Australia	7	17
France	8	12
Denmark	9	8
UK	10	18
Finland	11	10
F.R. Germany	12	11
New Zealand	13	22
Italy	14	19
Belgium	15	15
Spain	16	26
Ireland	17	24
Austria	18	13
USA	19	2

Source: United Nations Development Programme

least serve to remind us that economic growth is not a reliable indicator of human progress. Interestingly, the early economists were concerned with income as a measure of well-being. However, the actual process of measuring a nation's income has become more concerned with income as a measure of economic activity, of the "busy-ness" of the economy. Now, the pendulum has swung back again, and there is renewed interest in getting some measure of our sustainable well-being. It may well be feasible to combine the human development index with environmental indicators.

Trading in Sustainability

One country can be on a sustainable development path (i.e., keeping its own natural capital intact) at the expense of another (i.e., by reducing the other's natural capital). International trade could be the medium by which this "trade in sustainability" takes place. This idea has been popular from time to time, notably with the celebrated "hamburger connection," whereby North American hamburgers were alleged to be the ultimate cause of Central American deforestation. The connection was alleged to be beef exports from Central America, coming from cattle ranches that were developed on cleared tropical forest land. There is, in fact, no supporting evidence for the connection. But other trade linkages do exist. The case of the alleged connection between cassava imports and Netherlands beef production is briefly outlined below.

Cassava is a root crop widely grown for human consumption in the tropics and a rich source of feed for livestock. In recent years, international trade in cassava has risen from almost nothing to some eight million tonnes. It is exported from Thailand to the Netherlands, Germany and Belgium, where it is used as commercial feed for livestock. Cassava grows well on poor soils such as those in areas of cleared tropical forest, and, in the absence of artificial fertilizers, will deplete the nutrient content of the soils in which it grows. In north-east Thailand, although land has been cleared specifically to cultivate cassava for export, the linking of deforestation to European demand gives an incomplete picture of the complexity of the motives behind the clearing. For one thing, farmers would not have had access to the cleared plots in the first place had there not been earlier clearing to make way for new roads for military purposes. The road-building was followed not only by cropping but also by logging and clearing for livestock. Moreover, if they had not cleared it for the purpose of growing cassava, the

farmers — in their efforts to escape poverty — would have cleared the newly accessible land and cultivated it with some other crop. In fact, cassava is grown only on 25% of cleared forest land.[18] Clearly, European demand was not the instigator of deforestation in north-east Thailand, but rather, incidental when viewed in the broader context of the incentives and opportunities available to extremely poor people in the region, and infrastructural changes in transport made for non-economic reasons.

The cassava example raises the question of how an environmental indicator might be used to forewarn of situations in which one country is achieving sustainability at another's expense. One possibility is for any country suspecting that it is "importing sustainability" (i.e., causing non-sustainable resource use elsewhere) to identify the exporting countries, assess the likelihood that exports are non-sustainable and calculate an indicator of its imports from the exporting country as a proportion of total exports. Thus, if Thailand's cassava exports are non-sustainable, and if the Netherlands' imports are 80% of thoseexports, then, arguably, the Netherlands would be responsible for 80% of the cassava-related environmental damage in Thailand. The picture could quickly become complex. However, research in this area of trade-related environmental damage is still very much in its infancy.

Prioritisation of Policy-maker Information Needs

Summary of Preceding Chapters

The message of the preceding chapters may be summarized as follows:

- policy-maker information is contingent upon our understanding of what sustainable development means;
- sustainable development can be interpreted as a rising level of per capita "human development" over time;
- a minimal condition for supposing that development will be sustained is that a nation's capital assets should be at least maintained, and preferably improved;[19]
- the ecological interpretation of sustainability argues for special attention to be paid to "natural capital";
- environmental information must therefore focus on:
  - the "state of natural capital," i.e., the state of the environment;
  - measures of importance for damage done;
  - trends in the state of the environment over time, i.e., absolute trends and trends in environmental efficiency;
  - factors giving rise to past, current and future environmental change, i.e., indicators of pressure on the environment;
  - measures of policy efficiency, in order to determine the efficacy of past and current policy, as well as the directions of future policy. Such measures must include costs of policy (including both the spatial and the social incidence of costs and benefits).

This provides a coherent "story" for political decision-makers and advisers. It was suggested earlier that environmental information does not vary greatly according to user. However, the perspective may differ. If we view the preceding summary in terms of business decision-makers, then the sequence would be:

- review the state of the environment;
- assess company impact on the environment, and the importance of that impact — e.g., materials and energy usage per unit of sales (a feature of environmental audit);
- look at business activity to gauge the pressures on the environment (a further feature of a good environmental audit);
- look at company policy on the environment (in the form of "credos," "missions," corporate plans, etc.) and assess costs and benefits; and
- comply with government regulation.

It thus appears that the sequence holds up reasonably well for business policy decision-makers, as it does for political decision-making.

Therefore, the kinds of information required from this model are:

- "state" indicators;
- "trend" and efficiency indicators;
- "importance" indicators;
- "pressure" indicators; and
- policy cost indicators.

Table 8
Summary of Forms of Information

User	State	Trend	Indicator			
			Importance	Pressure	Policy Efficiency	Cost
Citizen/consumer	State indicator	State indicator	Public opinion			
Business	State indicator	State indicator	Public/expert opinion Public/expert opinion	Environmental audit Environmental audit	Environmental audit	Cost assessment
Government	State indicator	State indicator	Risk assessment Social cost analysis Public/expert opinion	Causal analysis	Causal analysis	Cost-benefit analysis
NGO	State indicator	State indicator	Risk assessment Expert opinion	Causal analysis	Causal analysis	
Multilaterals	State indicator	State indicator	Risk assessment Social cost analysis	Causal analysis	Post audits	Cost-benefit analysis
Examples	OECD environmental indicators		Opinion polls Social cost studies GNP estimates (see text)	Statistical regression (see text)	Operations evaluation reports (e.g., World Bank) Statistical regression (see text)	US EPA's "Lead in Gasoline" regulatory impact analysis (see text)

Table 9
Testing the Trade-related Factors Giving Rise to Tropical Deforestation

Data from 45 developing countries were used to test the factors giving rise to deforestation. The study related industrial logging to the factors noted in the table below. The hypothetical relationships tested were as follows:

- Higher timber prices raise the opportunity cost of leaving forests unharvested.
- Overvalued exchange rates could encourage forest depletion or, if devaluations are associated with "structural adjustment" packages, overvaluation might be inversely related to logging.
- High indebtedness encourages the use of forest land for export crops, including timber and agriculture.
- Population growth exerts pressure on unexploited forest land.

The measures shown are elasticities (i.e., the percentage change in forest depletion with each 1 percent change in the variable). The results can be interpreted as follows:

In 1967-71, when exchange rates were relatively fixed, the export price of logs dominates the explanation of deforestation. For each 1 percent change in the price of logs, there was a 1.5 percent increase in the area of forest logged.

	Model 1	Model 2	Model 3
1967-1971			
Export price logs	1.45**	1.49**	1.50**
1972-1975			
Per capita income	2.18**	2.18**	1.96**
Agric. export prices	0.86	1.11*	0.96
Debt service ratio	-1.15	-1.51	-1.46
Cereal self-sufficiency	5.12**	4.84**	4.71**
Population	0.26	0.26	0.26*
1976-1980			
Per capita income	1.43	1.61*	1.29
Devaluation rate	4.10**	4.67**	3.16*
Cereal self-sufficiency	4.61	5.41*	4.19
1981-1985			
Devaluation rate	1.40*	1.40*	1.02
Arable land per capita	3.74**	4.01**	2.86*

* significant at the 5% level
** significant at the 1% level

Source: A.D. Capistrano and C. Kiker, "Global Economic Influences on Tropical Closed Broadleaved Forest Depletion 1967-1985," Food and Resource Economics Department, University of Florida, Gainseville, May 1990, mimeo.

Table 8 summarizes informational needs by type of information, by user, and by means of eliciting and presenting the information.

Of the modes of information in Table 8, only the "statistical analysis" and "cost-benefit analysis" items require any elaboration. Table 9 illustrates the statistical analysis in terms of an evaluation of the causes of tropical deforestation. Table 10 illustrates a well executed cost-benefit analysis.

In 1972-75, efforts to promote cereal self-sufficiency were associated with forest depletion, which increased by 4.7-5.1 percent for every 1 percent change in cereal self-sufficiency. Real income growth was also important with an elasticity of 2. Notice that the link between income growth and deforestation is positive contrary to the popular "poverty hypothesis." Another finding which contradicts popular views is that the debt service ratio is related to depletion in an inverse manner. The connection here may be that easier credit removed the pressure to raise logging rates. Agricultural prices also generally rose in this period, giving some incentive to clear forests for agriculture.

In 1976-80, there was a strong association between devaluation and forest depletion. Increased demand abroad for cheaper exports would be an incentive to "mine" forests to secure foreign exchange advantages and to substitute for dearer imports. Both income and cereal self-sufficiency exerted a continued impact during this period.

In the 1976-86 period, the expansion of arable lands became the most important factor explaining depletion, and exchange rate devaluations continued to have an impact.

The above table shows the results of a cost-benefit analysis carried out by the US EPA in connection with regulations concerning lead in gasoline. It was designed to test the assumptions that ambient lead concentrations were linked to serious health effects. Although health

Table 10
Case Study in the Use of Cost-Benefit Analysis in Decision-making: Lead in Gasoline

Year-by-year costs and monetized benefits of Final Rule, assuming partial misfuelling* (in millions of 1983 dollars)

	1985	1986	1987	1988	1989	1990	1991	1992
Monetized Benefits								
Children's health effects	223	600	547	502	453	414	369	358
Adult blood pressure	1,724	5,897	5,675	5,447	5,187	4,966	4,682	4,691
Conventional pollutants	0	222	222	224	226	230	239	248
Maintenance	102	914	859	818	788	767	754	749
Fuel economy	35	187	170	113	134	139	172	164
Total Monetized Benefits	12,084	7,821	7,474	7,105	6,788	6,517	6,216	6,211
Total Refining Costs	96	608	558	532	504	471	444	441
NET BENEFITS	1,988	7,213	6,916	6,573	6,284	6,045	5,772	5,770

*misfuelling costs are associated with the use of leaded fuel in vehicles designed for unleaded fuels.

benefits dominate the results, their removal does not change the fact that the benefits of introducing unleaded fuel outweigh its costs.

The monetization of benefits included reductions in: medical costs; the costs of compensatory education for impaired children; costs associated with mortality/morbidity in adults (medical costs, lost labour, etc.); cost estimates of ozone pollution and other damage associated with emissions (mainly HC, NOx and CO), which are also reduced as a result of burning unleaded fuel; and vehicle maintenance. Expected increases in fuel efficiency associated with the development of higher-octane unleaded gasolines were also included.

Setting Priorities for Environmental Information

Information is not without cost. It is important, therefore, to establish priorities in terms of its generation and use. Various criteria for selecting information may be devised. We suggest some sort of benefit-cost assessment, that is, the aim should be to focus first on that information which yields the highest net gains to the user (or the community for which the user acts). Such evaluations will necessarily require the exercise of judgement. Our own approach to priorities is set out below.

The "Importance" of environmental degradation

The first priority is to establish what matters. In terms of the foregoing discussion on sustainable development, one priority becomes the provision of indicators or information on the extent of natural asset depreciation. To understand what is required, we may contrast an emissions indicator with a stock indicator. If emissions do not exceed the receiving capacities of natural environments, then although some damage may ensue, sustained damage is unlikely and the "stock" of the environmental receiving medium need not be affected. In other words, emissions indicators provide useful environmental information, but they do not directly inform the decision-maker about sustainability. Some measure of the ratio of emissions to receiving capacity is required.

In practice, this is extremely complex, not least because, in many cases, the concept of "receiving capacity" cannot be readily translated into measurable form. It is more likely to be definable in resource-using contexts. Figure 11 shows the OECD indicator set for water extraction rates relative to regenerated supply, and Table 11 shows measures of "carrying capacity" in the Sahelian zones of Western Africa. Both measures adopt a ratio of "use-to-receiving capacity" indicator.

Attention needs to be focused on the development of analogous indicators for pollution. Typically, the "critical loads" concept is relevant here, although it should be used with care. The critical load refers to a threshold at which pollution concentrations begin to cause damage. Whereas carrying capacity refers to a "limit" of capacity, beyond which human welfare declines significantly, a critical load can be exceeded without major impairment of welfare. Figure 12 shows a possible interpretation.

The difference arises because carrying capacities are usually defined with respect to a population living at some minimum resource intake level. Critical loads, on the other hand, simply refer to the threshold point where some damage occurs. Determination of this threshold level is also extremely complex because of the diversity of receiving environments. For example, the speed and extent to which waterways become acidified as a result of acidic deposition depends on the characteristics of the surrounding soil and vegetation. As well, the extent of damage to aquatic life will depend on its ability to tolerate a more acidified environment.

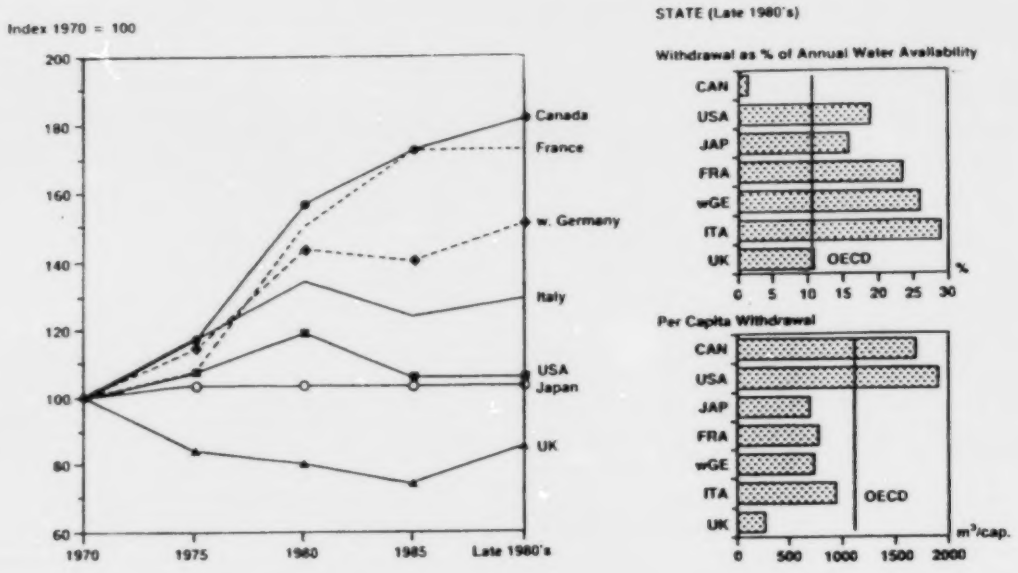
Use-to-capacity measures, if they can be developed more widely, need to be supplemented by further elaboration of the types of environment-economy indicators already under development by OECD and other countries.

It is worth noting that an entire array of assessment procedures is required for such indicators. Geographical information systems in general, together with overlays of socio-economic data, assist in the provision of both indicators and move to the next level of information — causal analysis.

In assessing the "importance" of environmental degradation, the second priority is to establish health-environment indicators. While environmental epidemiology is well developed, remarkably few measures of "excess mortality and morbidity" statistics are published, linking health to environmental hazards.

The third priority lies in measuring the social cost of environmental degradation (previously discussed). The fourth priority lies in securing measures of public and expert opinion on environmental risk (also previously discussed). The fifth priority lies in modifying national accounting systems.

Figure 11
Water Use Intensity Trends and Withdrawal as a Percentage of Gross Annual Availability



	1970	1975	1980	1985	Late 1980s	m3 per capita late 1980s
	%	%	%	%	%	
Canada	0.8	0.9	1.2	1.3	1.4	1,691
USA	17.8	19.1	21.2	18.8	18.8	1,896
Japan	15.1	15.5	15.5	15.5	15.5	692
N. Zealand	0.2	0.3	0.3	0.5	0.5	571
Denmark	6.5	9.5	10.9	11.2	10.0	254
Finland	3.2	3.4	3.6	3.8	3.8	809
France	13.5	14.6	20.3	23.3	23.4	774
W. Germany	17.1	19.5	24.5	24.0	25.8	722
Italy	22.4	26.3	30.1	27.8	28.9	940
Netherlands	14.7	15.3	16.4	16.1	16.1	980
Norway	0.5	0.6	0.5	0.6	0.6	531
Spain	22.3	32.7	36.2	41.0	41.6	1,176
Sweden	2.0	2.3	2.0	1.6	1.7	355
Switzerland	1.3	1.3	1.3	1.4	1.4	106
Turkey	7.0	9.6	9.7	11.6	17.7	548
UK	13.0	10.9	10.4	9.6	11.0	262
OECD	8.6	9.4	10.5	10.0	10.2	1,106

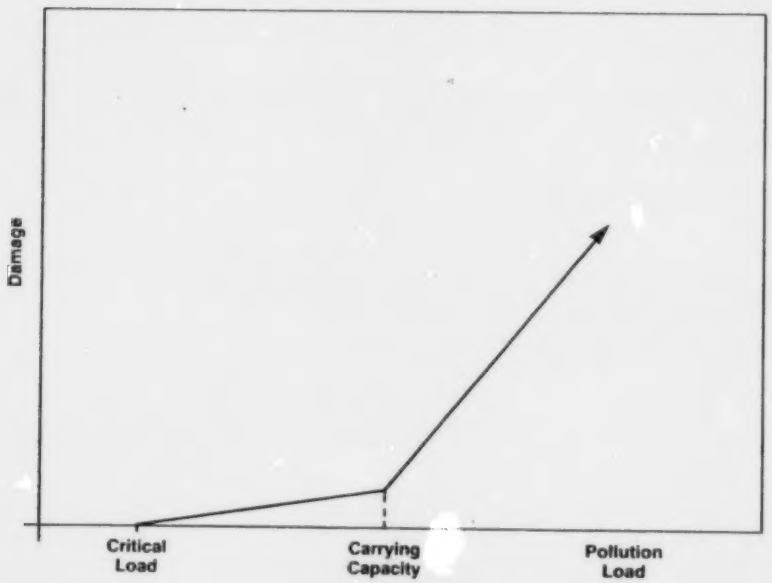
Source: OECD. OECD Environmental Indicators 1991. OECD, Paris (1991).

Table 11
Carrying Capacities in Sahelian/Sudanian Zones of West Africa

Zones	Sustainable Population			Actual Rural Population	Sustainable Population	Actual Rural Population
	Crops	Livestock	Sum		Fuelwood	
Saharan	—	0.3	0.3	0.3	—	0.3
Sahelo-Saharan	—	0.3	0.3	2	—	2
Sahelian	5	2	7	7	1	7
Sahelo-Sudanian	10	5	15	20	10	23
Sudanian	15	7	22	17	20	21
Sudano-Guinean	25	10	35	9	20	10

Source: D. Steeds. Desertification in the Sahelian and Sudanian Zones of West Africa. World Bank, Washington, DC (1985).

Figure 12
Critical Load/Carrying Capacity



Thus, under the criterion of importance we suggest the following ranking:

- use-to-capacity ratios, and other "basic" indicators (e.g., environment-economy)
- health-environment indicators
- social cost measures
- expert and public opinion
- modified national accounting systems.

The causes of environmental degradation

Our second "set" of indicators/information relates to causal factors. We have already indicated that such information requires expertise in terms of statistical analysis and presentation. In Table 12, we offer a further example of a statistical analysis, this time with a clear policy implication that investing in soil enhancement in degraded forest lands will have a high environmental rate of return in terms of reduced deforestation.[20]

Table 12
Agricultural Expansion and Tropical Deforestation

In a 23-country study of agricultural expansion, Douglas Southgate identified the following principal causal factors:

- Population growth which increases demand for products of agriculture (but does not significantly increase demand for land, as urban migration outstrips fertility in most countries surveyed).
- Growth in agricultural exports.

He also identified two factors as significant deterrents to colonisation:

- The formation of non-environmental assets (e.g., human capital and managerial talent) to produce better farming practices and increase yields.
- Institutional factors, such as secure tenure for cultivators and restriction of relatively unrestricted access to forested lands.

The policy implications of the latter two factors are significant, since they are clearly within the scope of agricultural and economic planning agencies' mandates. Population growth and external demand factors are much more difficult, if not impossible, to plan for and control.

Source: D. Southgate. "Tropical Deforestation and Agricultural Development in Latin America," (November 1990), mimeo.

Policy analysis will also tend to reflect on causal processes, and may or may not involve statistical analysis. In policy analysis, the effectiveness of environmental policy is investigated in detail. Relevant disciplines include environmental science, political science and economics.[21]

Policy costs

The third form of information required relates to the costs of adopting policies. Such costs tend to be divided between the public and private sectors as, for example, in waste water treatment. In both sectors, it is important to know the costs of compliance with regulation. Surprisingly, these often appear to be known only imperfectly, and sometimes not at all. It is difficult to see how policy-makers can make rational environmental decisions without knowing the costs of regulation. Where, as in the USA, some form of "regulatory impact assessment" legislation exists, the costs of specific regulations tend to be reasonably well known. Even so, the costs of overall programmes of regulation are not likely to be known with any precision.[22]

Who gains, who loses

Decision-makers need to know more than the overall costs and benefits of policies and actions; they need to know who bears the costs and who secures the benefits. Indeed, it is widely acknowledged that development that ignores the social incidence of gains and losses may well be unsustainable.[23]

Table 13 shows an example of incidence analysis for the UK in respect of a hypothetical tax on energy designed to reduce carbon dioxide emissions.

Table 14 summarizes our prioritisation of policy-maker information.

Table 13
Distributional Effects of Tax on Domestic Energy

Household spending on domestic fuel and power: The effects of a 15% increase in price (by quintile of gross household income)

	Poorest	2	3	4	Richest
Household income (£p.w.)	53.70	112.65	196.10	291.70	520.35
Spending on fuel and power before tax change (£p.w.)	8.55	10.45	10.96	12.01	13.96
Increase in tax paid (£p.w.)	1.17	1.44	1.48	1.60	1.80
Change in consumption of fuel and power	-9.9%	-8.5%	-6.5%	3.0%	1.9%

The above table shows the effect of a value-added tax, which would increase the price of domestic energy sources by 15 percent. The distributional effects of higher prices for domestic energy bear particularly heavily on poorer households. Not strongly related to income, household spending on energy in absolute terms changes little in response to the imposition of the tax over the range of income levels. The impact on actual consumption is, however, more marked, with the poorest reducing their consumption by almost 10 percent and the richest by almost nothing.

Sources: S. McKay, M. Pearson and S. Smith. "Fiscal Instruments in Environmental Policy," Fiscal Studies (November 1990).

M.A. Pearson and S.R. Smith. "Taxation and Environmental Policy: Some Initial Evidence," IFS Commentary no. 19, Institute for Fiscal Studies, London (1990).

Table 14
Priorities for Environmental Information

Criterion	Ranking of Information	Comment
Importance of effect	Environment-economy indicators and use to capacity ratios	See OECD Indicators programme — tends to be reasonably well documented
	Health impacts	Individual country efforts and World Bank — no systematic approach
	Social cost measures	
	Expert/public opinion	Often not available in structured form
		Widely available in OECD countries
	Accounting systems	Various country efforts; World Resources Institute programme, UNEP, World Bank and OECD programmes; UNSO
Causes	Statistical analysis	Surprisingly limited exercises
	Policy analysis	Extensive in OECD
Costs	Abatement technology costs	Usually known, but often in unsystematic manner
	Overall compliance costs	Frequently not known, even in OECD countries
Incidence	Incidence analysis: intragenerational	Less frequently carried out than benefit or cost assessment; major data problems in many cases
	Incidence analysis: intergenerational	Subject to major uncertainties, but critical to sustainable development

Gaps in Information for Global Environmental Decision-Making

While substantial amounts of information exist on environmental conditions in both the industrialized and the developing worlds, the information is notably weakest in the context of a number of global environmental issues that cause considerable concern. In particular, we highlight several broad factors that are frequently linked to environmental degradation:

- the role of international trade;
- the role of international indebtedness;
- poverty and the environment; and
- aid and the environment.

While there are deeply held views on all these issues, remarkably little analysis is available to shed light on what the connections actually are.

A typical linkage, for example, might be that indebtedness gives rise to a drive for exports in order to pay interest on the debt. The export drive may, in turn, divert resources from "ecologically sound" subsistence crops into "ecologically unsound" export crops, or into the export of timber, polluting industries and so on. The greater the debt, the greater the resource diversion and the more the environmental degradation. While this is a plausible story, it is not one for which we have substantive evidence. Two informational approaches are possible:

- exploring the various linkages in the sequence;

- inspecting the overall relationship between indebtedness and environmental decay.

In the first approach, questions arising are, for example:

- Why are subsistence crops thought to be environmentally benign? (Many are not — e.g., sorghum, millet.)

- Why are export crops thought to be environmentally harmful? (Many are not — e.g., coffee, tea. It depends on where they are grown.)

Under the second approach, one could statistically analyse the relationship between, say, deforestation and indebtedness. Few studies of this kind appear to exist.[24]

In the absence of such information, it is difficult to see how productive discussions on a more "environmentally friendly" international trading regime can take place. Moreover, unless aid policies are based on this kind of information, the benefits of environmentally sensitive aid may quickly be lost due to macro-economic problems that are unrelated to aid.[25]

Towards Indicators of Sustainability

Earlier in this paper, we investigated the meaning of sustainable development in order to arrive at some operational definition of the term. Sustainable development was seen as a process of human advancement. If "development" is more than income per capita, there must be some agreement on its meaning. We need to do more than simply observe past trends of "development indicators" in order to determine whether or not a country (region, business, international zone, etc.) is on a "sustainable" development path.

From this, it can be seen that the development of sustainability indicators is fraught with difficulty. Nonetheless, some progress can be made by determining what might be regarded as germane to such indicators. At a minimum, the relevant information would appear to be:

- the development, as a longer-term aim, of a measure of "sustainable income," through modified GNP accounting;

- renewable resource use indicators — e.g., indicators showing the rates at which renewable resources are being extracted and renewed. Figure 13 shows an indicator of this kind for forest use in OECD countries. All countries are seen to be harvesting forest resources sustainably, with (West) Germany coming close to a constant stock situation. Other countries are harvesting a yield that is more than sustainable, and hence their stocks are increasing. Table 15 shows catch rates for ocean fisheries against estimated sustainable yield. The figure shows clearly that the Pacific Northwest fishery is unsustainably managed, as is the Mediterranean/ Black Sea fishery, and possibly also those of the East Central Atlantic, the Eastern Indian Ocean, and the Southeast and Eastern Central Pacific;

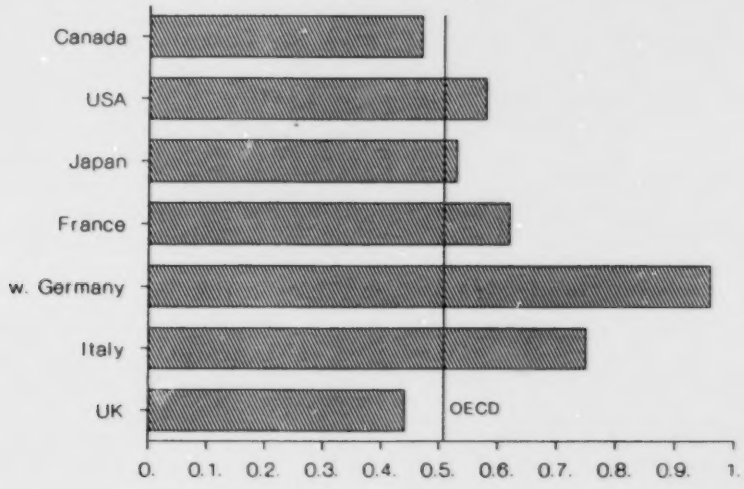
- some indicator of exhaustible resource use. The concept of "sustainable use" in this context would appear to be inappropriate since, if a resource is exhaustible, any use rate will deplete it. However, physical scarcity indicators are not particularly relevant here, because exhaustible resources are subject to new discoveries and, more importantly, to technological change in both extraction and use. The effect of technological change is to make the productivity of all remaining stocks higher than that of previously depleted stocks. Possible indicators include:

    - Resource prices: if commodity markets worked freely, we might expect all these factors to show up in resource prices. Briefly, if (real) resource prices are constant over time, or if they decline, then the resource is not "scarce" in the economic sense. If they rise, then the resource is getting scarcer.[26]

    - Share of resource use accounted for by renewables: as exhaustible resources are depleted, they will tend to be substituted for by other exhaustibles or renewables (e.g., solar energy for coal). Thus, one might use the share of total resource use accounted for by renewables as an indicator of movement towards sustainability. The higher the ratio, the more sustainable the development is likely to be.

In our view, there is still a considerable way to go before we can confidently present sustainability indicators. But policy-makers have a clear and emphatic need for such indicators if we are to embrace sustainable development as a goal.

Figure 13
Intensity of Use of Forest Resources (harvest/annual growth)
Period 1980-85



	Growing stock m^3/ha	Annual increment m^3/ha	Annual harvest million m^3(a)			Intensity of use total harvest/annual growth		
	1980-85	1980-85	1950s	1970s	1980-85	1950s	1970s	1980-85
Canada	74.3	1.7	71.1	121.4	151.3	..	..	0.47
USA	109.3	3.6	304.6	397.4	442.7	0.60	0.57	0.58
Japan	105.8	3.0	73.2	50.5	40.6	..	..	0.53
Australia	64.4	1.0	..	..	16.3	..	..	0.39
New Zealand	150.9	14.7	2.8	8.6	10.2	..	..	0.87
Austria	274.0	6.2	11.2	15.1	15.2	1.37	0.81	0.78
Belgium	148.0	7.5	2.7	3.2	2.8	1.18	1.23	0.62
Denmark	141.0	7.7	2.2	2.5	2.1	0.88	1.09	0.75
Finland	88.0	3.2	48.9	54.7	53.6	0.92	0.98	0.82
France	120.0	4.0	35.5	34.7	39.5	1.09	0.75	0.62
W. Germany	224.0	5.7	35.3	33.7	40.9	1.41	0.99	0.96
Greece	73.0	1.8	4.0	35.0	2.9	1.03	0.88	0.71
Ireland	102.0	7.3	0.2	0.4	0.9	0.67	0.22	0.32
Italy	154.0	3.1	15.4	11.9	9.0	1.04	0.85	0.75
Netherlands	103.0	4.2	0.8	1.2	1.2	1.20	0.98	0.95
Norway	83.0	2.6	11.9	10.2	11.3	0.83	0.65	0.63
Portugal	90.0	4.4	5.4	7.5	10.8	1.00	0.92	0.94
Spain	68.0	4.3	14.2	16.8	13.3	..	0.66	0.48
Sweden	101.0	3.0	43.5	66.6	57.6	0.76	1.05	0.70
Switzerland	364.0	5.6	4.2	4.8	4.8	0.88	0.91	0.91
Turkey	58.0	2.9	7.2	19.9	19.6	..	1.04	1.02
UK	108.0	5.6	4.3	4.2	5.2	1.39	0.67	0.44
Yuglosavia	138.0	3.5	35.2	23.8	21.2	2.38	1.06	0.72
OECD	93.2	2.6	703.3	914.3	952.1	..	..	0.52

Note : (a) Over bark volumes
Source : OECD *Environmental Indicators, 1991*, OECDE Paris, 1991

Table 15
Annual Catch and Sustainable Yield of Regional Marine Fisheries

	Average annual catch[a] ('000 metric tons)		Estimated sustainable yield[b] ('000 metric tons per year)
	1975-77	1985-87	
ALL MARINE FISHERIES	60,948	78,955	62,250-95,950
Atlantic, Northwest			
Total catch	3,372	2,930	3,400-4,300
Cods, hakes, haddocks	867	881	
Herrings, sardines, anchovies	613	503	
Clams, cockles, arkshells	226	416	
Redfishes, basses, congers	251	209	
Flounders, halibuts, soles	236	212	
All others	1,179	708	
Atlantic, Northeast			
Total catch	12,585	10,690	10,100-12,300
Cods, hakes, haddocks	4,143	3,580	
Herrings, sardines, anchovies	1,923	1,747	
Redfishes, basses, congers	1,162	1,275	
Jacks, mullets, sauries	3,217	1,740	
Mackerels, snoeks, cutlassfishes	757	580	
All others	1,381	1,768	
Atlantic, Western Central			
Total catch	1,510	2,188	3,200-5,100
Herrings, sardines, anchovies	850	992	
Miscellaneous marine fishes	134	275	
Shrimps, prawns	169	186	
Oysters	176	194	
Redfishes, basses, congers	150	115	
All others	232	405	
Atlantic, Eastern Central			
Total catch	3,613	3,047	2,900-3,700
Herrings, sardines, anchovies	1,386	1,180	
Jacks, mullets, sauries	648	405	
Miscellaneous marine fishes	371	353	
Redfishes, basses, congers	340	298	
Tunas, bonitos, billfishes	243	246	
All others	626	565	

Table 15 Cont'd.

	Average annual catch[a] ('000 metric tons)		Estimated sustainable yield[b] ('000 metric tons per year)
	1975-77	1985-87	
Atlantic, Southwest			
Total catch	893	1,847	2,600-3,900
Squids, cuttlefishes, octopuses	6	456	
Cods, hakes, haddocks	236	593	
Redfishes, basses, congers	215	277	
Herrings, sardines, anchovies	172	143	
Shrimps, prawns	45	76	
All others	218	301	
Atlantic, Southeast			
Total catch	2,656	2,303	2,500-3,100
Herrings, sardines, anchovies	994	837	
Jacks, mullets, sauries	612	645	
Cods, hakes, haddocks	586	510	
Miscellaneous marine fishes	83	88	
Redfishes, basses, congers	99	78	
All others	202	166	
Indian Ocean, Western			
Total catch	2,051	2,605	2,700-4,200
Redfishes, basses, congers	426	491	
Tunas, bonitos, billfishes	158	446	
Miscellaneous marine fishes	344	524	
Herrings, sardines, anchovies	339	379	
Shrimps, prawns	242	240	
All others	543	524	
Indian Ocean, Eastern			
Total catch	1,190	2,277	1,500-2,200
Miscellaneous marine fishes	507	983	
Redfishes, basses, congers	129	214	
Herrings, sardines, anchovies	119	191	
Jacks, mullets, sauries	58	127	
Shads	3	112	
All others	274	649	
Pacific, Northwest			
Total catch	17,568	25,187	13,500-16,500
Herrings, sardines, anchovies	1,888	5,831	
Cods, hakes, haddocks	3,950	5,282	
Miscellaneous marine fishes	3,634	4,716	
Mackerels, snoeks, cutlassfishes	2,176	1,869	
Redfishes, basses, congers	1,470	1,399	
All others	4,549	5,091	

Table 15 Cont'd.

	Average annual catch[a] ('000 metric tons)		Estimated sustainable yield[b] ('000 metric tons per year)
	1975-77	1985-87	
Pacific, Northeast			
Total catch	2,142	3,156	2,600-3,200
Cods, hakes, haddocks	1,228	1,933	
Flounders, halibuts, soles	182	368	
Salmons, trouts, smelts	182	383	
Redfishes, basses, congers	177	154	
Herrings, sardines, anchovies	112	78	
All others	262	240	
Pacific, Western Central			
Total catch	5,447	8,369	5,800-7,800
Miscellaneous marine fishes	1,812	1,657	
Tunas, bonitos, billfishes	821	1,184	
Jacks, mullets, sauries	729	840	
Herrings, sardines, anchovies	570	683	
Redfishes, basses, congers	544	637	
All others	1,170	1,368	
Pacific, Eastern Central			
Total catch	1,506	2,523	2,200-3,000
Herrings, sardines, anchovies	742	1,350	
Tunas, bonitos, billfishes	436	534	
Miscellaneous marine fishes	97	246	
Shrimps, prawns	75	141	
Mackerels, snoeks, cutlassfishes	4	161	
All others	152	191	
Pacific, Southwest			
Total catch	387	745	1,200-2,000
Cods, hakes, haddocks	98	169	
Jacks, mullets, sauries	42	124	
Redfishes, basses, congers	58	148	
Miscellaneous marine fishes	21	72	
Squids, cuttlefishes, octopuses	32	112	
All others	136	120	
Pacific, Southeast			
Total catch	4,898	10,528	3,700-10,300
Herrings, sardines, anchovies	3,590	7,663	
Jacks, mullets, sauries	532	2,294	
Cods, hakes, haddocks	161	173	
Redfishes, basses, congers	49	100	
Mackerels, snoeks, cutlassfishes	108	66	
All others	258	332	

Table 15 Cont'd.

	Average annual catch[a] ('000 metric tons)		Estimated sustainable yield[b] ('000 metric tons per year)
	1975-77	1985-87	
Mediterranean and Black Sea			
Total catch	1,225	1,966	1,090-1,410
Herrings, sardines, anchovies	584	852	
Jacks, mullets, sauries	95	216	
Redfishes, basses, congers	117	150	
Miscellaneous marine fishes	113	130	
Mussels	22	96	
All others	294	521	
Antarctic			
Total catch	172	416	X
Krill, planktonic crustaceans	65	338	
Redfishes, basses, congers	108	73	
Jacks, mullets, sauries	1	1	
Miscellaneous marine fishes	8	3	
Miscellaneous marine molluscs	0	0	
All others	1	0	

Source: Food and Agriculture Organization of the United Nations

Notes:

a. "Catch" includes all fish, crustaceans and molluscs harvested in marine fishing areas.

b. "Estimated sustainable yield" refers to marine fish, crustaceans and cephalopods. It excludes ocean pelagic species (about 3.5 percent of total potential) and molluscs.

Notes:

Figures may not add because of rounding.
0 — zero or less than half the unit of measure; X — not available.

Source: World Resources Institute. World Resources 1990-91. World Resources Institute, Washington, DC (1991).

Summary and Issues for Further Discussion

This paper has been concerned with the provision of environmental information as seen from the perspective of the policy decision-maker. We may summarize the main points as follows:

1. The whole framework for sustainable development requires that we look at the environment in the context of socio-economic progress (and decline). Such progress both causes environmental change and reacts to it. The "pressure-state-response" model, as espoused by the OECD Environmental Indicators Program, captures much of this linkage.

2. Policy-makers need information which:

- is guided by an operational meaning of sustainable development;
- permits the "pressure-state-response" linkage to show through;
- enables the environmental efficiency of the economy to be perceived;
- is guided by measures of importance, based on expert assessment of social cost and risk, and public opinion;

- is conducive to policy analysis — in particular, it must be accompanied by information on the cost of any measures; and
- is reasonably "transparent" in terms of interpretation.

3. Definitions of sustainable development abound; however, we recommend that it be interpreted in terms of:

- an index of human development;

- a requirement that nature's capital be used sustainably, in terms of:
  - sustainable yield and regeneration rates for renewable resources;
  - real resource prices for exhaustible resources with markets; and
  - shares of renewable resources (used sustainably) in the total of resources used; and

- some measure of the "trade" in sustainability.

4. While we have generally discussed the issues in terms of nations, in our view the requirements for decision-makers in the business sector are directly analogous. Table 2(b) summarized the environmental information needs of decision-makers, and Table 8, the various forms of environmental information.

5. We consider it essential to grade information according to its importance. The indiscriminate gathering, analysis and communication of data is a waste of resources. What is needed is environmental information in a form useable to the relevant decision-maker. Table 14 gives an outline of what we feel are priorities for environmental information, including some of the difficulties involved in the acquisition and application of such information.

6. We consider that while the development of "true" sustainability indicators may be some time off, these will, nevertheless, be a long-term imperative for cost-effective, reliable environmental planning. In light of this, environmental information needed by planners must be viewed in terms of its contribution to the development of such indicators.

NOTES

See R. Train, *Corporate Use of Information Regarding Natural Resource and Environmental Quality*, World Wildlife Fund U.S., for U.S. Council on Environmental Quality, Washington, DC (1984).

[2]Examples are countless and would include the *Environmental Reporter*, and the British *Environmental Data Service*, both of which are privately run organizations.

[3]OECD, *Environmental Indicators: A Preliminary Set*, OECD, Paris (1991).

[4]For surveys of monetary valuation techniques, see D.W. Pearce and A.M. Markandya, *Environmental Policy: The Benefit of Monetary Valuation*, OECD, Paris (1989). A simple introduction is D.W. Pearce, A.M. Markandya and E.B. Barbier, *Blueprint for a Green Economy*, Chapter 4, Earthscan, London (1990).

[5]See Y.J. Ahmad, S.E. Serafy, E. Lutz, eds. *Environmental Accounting for Sustainable Development* (A UNEP-World Bank Symposium). The World Bank, Washington, DC (1989).

[6]e.g., whether or not "defensive expenditures," that is, expenditures by consumers and others on noise and other pollution abatement, should be deducted from GNP. It would appear that consumers' expenditures should be, but business expenditures should not.

[7]D.W. Pearce et al. *Blueprint for a Green Economy*. op. cit.

[8]World Commission on Environment and Development. *Our Common Future*. Oxford University Press, Oxford (1987).

[9]See: OECD. *Pollution Control and Abatement Expenditure in OECD Countries*, Environment Monograph No. 38. OECD, Paris (November 1990).

[10]See D.W. Pearce. "New Environmental Policies: Recent OECD Experience and its Relevance to the Developing World." OECD Development Centre, Paris, in press (1991).

[11]M. Hazilla and R. Kopp. "The Social Cost of Environmental Quality Regulations: A General Equilibrium Analysis." Resources for the Future Discussion Paper QE 86-02, Washington, DC (1986).

[12]authors' calculations

[13]See D.W. Pearce and A. Markandya. "Marginal Opportunity Cost as a Planning Concept in Natural Resource Management," in S. Schramm and J. Warford, eds. *Environmental Management and Economic Development*. Johns Hopkins University Press, Baltimore (1989).

[14]H. Daly and J. Cobb. *For the Common Good: Redirecting the Economy Toward Community, the Environment and a Sustainable Future*, Beacon Press, Boston (1989).

[15]D.W. Pearce, R.K. Turner et al. *The Development of Environmental Indicators*, a Report to the UK Department of the Environment (February 1991).

[16]Quoted in P. Portney. "Air Pollution Policy," in P. Portney, ed. *Public Policies for Environmental Protection*. Resources for the Future, Washington, DC (1990).

[17]United Nations Development Programme. *Human Development Report 1990*, Oxford University Press, Oxford (1990).

[18]A. van Amstel, E. Baars, J. Sijm and H. Denne. *Tapioca from Thailand for the Dutch Livestock Industry*. Institute for Environmental Studies, Free University of Amsterdam, Amsterdam (1986).

[19]Indeed, if assets are only maintained and population grows, then "assets per capita" will decline. Development may or may not be sustainable, depending on the rate of technological change.

[20]We note with interest that, while relatively few statistical analyses of the causes of environmental degradation (or improvement) exist, those that do tend to be for *developing* countries and for deforestation. Apart from widespread public interest in tropical forests, we surmise that the bias reflects the difficulties of applying such analysis to other "major" environmental issues. For example, measures of "desertification" are few, and, where they do exist, extremely unreliable.

[21]Examples for the USA include: S. Luken, *Efficiency in Environmental Regulation: A Benefit-Cost Analysis of Alternative Approaches*. Kluwer, Boston and Dordrecht (1990).

[22]See Portney, op. cit.

[23]See Brundtland Commission, op. cit.

[24]For one example of such a study, see Capistrano and Kiker, op. cit.

[25]A useful analyis of the role of *structural adjustment* in contributing to environmental degradation can be found in I. Sebastian and A. Alicbusan, *Sustainable Development: Issues in Adjustment Lending Policies*, World Bank, Washington, DC (1989).

[26]The movement of real resource prices is the subject of a fairly extensive literature in economics -- see D. and J. Hall, "Concepts and Measures of Natural Resource Scarcity," *Journal of Environmental Economics and Management* (September 1984).

REFERENCES

Ahmad, Y.J., Serafy. S.E. and E. Lutz, eds. *Environmental Accounting for Sustainable Development* (A UNEP-World Bank Symposium). The World Bank, Washington, DC (1989).

Canada: State of the Environment Reporting Branch, Corporate Policy Group, Environment Canada, Report No. 17, *Environmental Indicators: Opinions of Potential Users* (April 1990).

Capistrano, A.D. and Kiker, C. "Global Economic Influences on Tropical Closed Broadleaved Forest Depletion 1967-1985," Food and Resource Economics Department, University of Florida, Gainesville (May 1990), mimeo.

Conway, G.R. *Helping Poor Farmers — A Review of Foundation Activities in Farming Systems and Agro-ecosystems Research and Development*. Ford Foundation, New York (1987).

Daly, H. and Cobb, J. *For the Common Good: Redirecting the Economy Toward Community, the Environment and a Sustainable Future*. Beacon Press, Boston (1989).

Hall, D. and Hall, J. "Concepts and Measures of Natural Resource Scarcity," *Journal of Environmental Economics and Management* (September 1984).

Hazilla, M. and Kopp, R. "The Social Cost of Environmental Quality Regulations: A General Equilibrium Analysis." Resources for the Future Discussion Paper QE 86-02, Washington, DC (1986).

Luken, R.A. Efficiency in Environmental Regulation: A Benefit-Cost Analysis of Alternative Approaches. Kluwer, Boston and Dordrecht (1990).

McKay, S., Pearson, M. and Smith, S. "Fiscal Instruments in Environmental Policy," *Fiscal Studies* (November 1990).

Organization for Economic Co-operation and Development (OECD). *Environmental Indicators: A Preliminary Set.* OECD, Paris (1991).

_____. OECD *Environmental Indicators* 1991. OECD, Paris (1991).

_____. *Pollution Control and Abatement Expenditure in OECD Countries.* OECD, Paris (November 1990).

_____. *The State of the Environment 1985,* "OECD, Paris (1985).

_____. *The State of the Environment 1991,* OECD, Paris (1991).

Pearce, D.W. "New Environmental Policies: Recent OECD Experience and its Relevance to the Developing World". OECD Development Centre, Paris (forthcoming 1991).

Pearce, D.W. and Markandya, A.M. *The Benefits of Environmental Policy: Monetary Valuation.* OECD, Paris (1989).

_____. "Marginal Opportunity Cost as a Planning Concept in Natural Resource Management," in G. Schramm and J. Warford, eds. *Environmental Management and Economic Development.* Johns Hopkins University Press, Baltimore (1989).

Pearce. D.W., Markandya, A.M. and Barbier, E.B. *Blueprint for a Green Economy.* Earthscan, London (1990).

Pearce, D.W. and Turner, R.K. et al. "The Development of Environmental Indicators," a Report to the UK Department of the Environment (February 1991).

Pearce, D.W. and Warford, J. *Environment and Development: Managing Natural Resources in the Developing World.* The World Bank, Washington, DC (forthcoming 1991).

Portney, P. "Air Pollution Policy," in P. Portney, ed. *Public Policies for Environmental Protection.* Resources for the Future, Washington, DC (1990).

Roberts, Leslie, "Counting on Science at E.P.A.," *Science,* Vol. 240 (10 August 1990).

Schramm, G. and Warford, J. *Environmental Management and Economic Development.* Johns Hopkins University Press, Baltimore (1989).

Sebastian, I. and Alicbusan, A. *Sustainable Development: Issues in Adjustment Lending Policies.* World Bank, Washington, DC (1989).

Southgate, D. "Tropical Deforestation and Agricultural Development in Latin America," (November 1990), mimeo.

Steeds, D. *Desertification in the Sahelian and Sudanian Zones of West Africa.* World Bank, Washington, DC (1985).

Train, R. *Corporate Use of Information Regarding Natural Resource and Environmental Quality.* World Wildlife Fund U.S., for U.S. Council on Environmental Quality, Washington, DC (1984).

United Nations Development Programme. *Human Development Report* 1990. Oxford University Press, Oxford (1990).

Van Amstel, A., Baars, E., Sijm, J. and Denne, H. *Tapioca from Thailand for the Dutch Livestock Industry.* Institute for Environmental Studies, Free University of Amsterdam, Amsterdam (1986).

World Commission on Environment and Development. *Our Common Future.* Oxford University Press, Oxford (1987).

World Resources Institute. *World Resources 1990-91.* World Resources Institute, Washington, DC (1991).

Theme Paper Two

Monitoring and Data Management Technology for Environmental Assessment

by

Harvey Croze
Global Resource Information Database

and

Veerle Vandeweerd
Global Environment Monitoring System

United Nations Environment Programme
Nairobi, Kenya

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Introduction

Decisions require information. Sound and timely information is necessary for policy formulation and decision-making and for guiding national, regional and global action for the sustainable management of natural resources and the environment, topics dealt with in the first theme paper of this series.

Environmental information is crucial in order to be able to:

- assess the impacts of human activity on the environment,
- manage, in a sustainable way, the natural heritage and world resources in their broadest sense,
- allow for sound and sustainable decision-making, including the incorporation of environmental and costing considerations in the economic decision-making process,
- anticipate environmental degradation of natural resources and prevent costly curative action,
- measure progress towards the achievement of sustainable development, and
- assess the long-term effects of management interventions.

Information is derived from inventory, monitoring and assessment programmes, whether they are global, regional or national. The ultimate objective of providing information to all levels of the global community is to bring environmental considerations to bear on all levels of resource utilization and development. At the very least, information-generation programmes should remove from decision-making the excuse of lack of information.

Environmental problems are frequently tackled in a reactive and haphazard fashion: policies are formulated to address each perceived crisis as it arises. They are forgotten as the crisis passes from public attention, and we move on to head off the next issue. A more proactive approach is needed, that of management for sustainable development. The process should incorporate a long-term strategic framework that enables global environmental problems to be dealt with comprehensively under a common goal. To build this strategic framework, a first requirement is the availability of sound and appropriate information, in a form accessible and usable by all.

Environmental information must be made available to its users in a format suitable for their purposes. Collecting information is not in itself a goal but a means to an end. Ideally, it should occur within a structured framework. The investigation of environmental problems requires the analysis, integration and presentation of many sets of data derived from different sectors. Appropriate data management and integration are necessary to bridge the gap between the information-generators on the one hand and the decision-makers on the other.

An informed citizenry is essential to the development of sustainable management practices. Public information is thus an essential part of any monitoring and assessment activity. The political support for global, regional and national monitoring, the acceptance of the information generated and the development and implementation of environmental policy all rely on the active participation of the global as well as the local population.

About twenty years ago, at the 1972 United Nations (UN) Conference on the Human Environment in Stockholm, the emphasis in the field of information was mainly on the acquisition of data to quantify environmental pollution problems. During recent years, as awareness of the breadth of environmental problems has become acute, the emphasis has shifted from data generation and problem qualification to cross-sectoral information integration, analysis and assessment, to the establishment of cause-and-effect relationships, to the provision of predictive capabilities and early warnings, and to the stipulation of management-option analysis. The traditional sectoral approach to monitoring has been overtaken by a need for a more integrated, multidisciplinary approach to meet the complex requirements of comprehensive environmental assessments.

In 1972, environmental monitoring was not yet a globally perceived need and many countries lacked monitoring capabilities in a variety of fields. With some exceptions, environmental issues were not yet quantified and there was little international co-operation. This situation has drastically changed in the last ten years. Most industrialized countries now have a monitoring mechanism in place, although it may not always be comprehensive. In general, developing countries are still short of monitoring capability, not for lack of interest but for lack of money and because of the pressing priorities of basic human needs. In many countries, vast amounts of often disparate information are available, and these now need to be brought together in integrated evaluations to support the drive for sustainable development. Furthermore, major new technological advances

(e.g.,remote sensing) are now available to help in the generation of data and in its compilation, analysis, presentation and use. These include powerful microcomputers, Geographical Information Systems (GIS), expert systems, artificial intelligence and simulation modelling. Ready and almost universal access to such tools changes the way we think about and deal with environmental information. It follows from all this that the environmental monitoring which generates such information must now operate differently than it did 20 years ago.

Purpose and Scope

This paper will outline major issues associated with the acquisition, storage, management and communication of environmental data and information. First, it will focus on the tools and techniques for the generation and management of environmental information for policy formulation and decision-making. It will then present some examples of existing monitoring and assessment programmes which have successfully contributed to the sustainable management of the environment. The paper will next highlight some of the global responses aimed at improving the generation, management and uses of environmental information. The final section will review the major issues addressed.

Techniques for Generating and Managing Environmental Information

Monitoring is the systematic, continuous, institutionalized collection, analysis and reporting of data and information. The first step in a monitoring programme is a baseline inventory, and monitoring may be viewed as a planned and orderly time series of inventories.

Assessment goes further. It entails the integration and evaluation of information on one or more elements of the environment, using data-handling techniques to produce a description of states and trends, possible cause-and-effect correlations, future projections for forecasting and early warning, and policy and management options. (Theme Paper Three deals in greater detail with reporting of environmental information).

Monitoring

Objectives of monitoring

Monitoring programmes are carried out for a multiplicity of reasons, including, for example:

- the establishment of baseline conditions to measure the impact of global change on these conditions (e.g., the World Meteorological Organization (WMO) Global Atmosphere Watch programme);
- the description of the status of, and trends in, environmental conditions and processes and the rate of observed changes (e.g., monitoring programmes conducted within the framework of the Global Environment Monitoring System (GEMS), including the Background Air Pollution Monitoring Network (BAPMoN), GEMS/ WATER and GEMS/AIR);
- the development of resource inventories (e.g., the Food and Agriculture Organization/United Nations Environment Programme (FAO/UNEP) and the Global Assessment of Tropical Forest Resources);
- the collection of data for modelling and prediction purposes and for the validation of developed models (e.g., the International Geosphere and Biosphere Programme (IGBP) and greenhouse gases monitoring (GGM) programmes);
- the collection of data for guiding policy decisions and the development and management of resources (e.g., desertification assessment);
- the collection of information to set policy and action priorities (e.g., in national programmes, such as the USA's Environmental Protection Agency (EPA));
- the evaluation of project/programme performance and of the effect of management interventions;
- the evaluation of adherence to and impact of international agreements, national and international control policies and management decisions (e.g., World Conservation Monitoring Centre (WCMC) and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES));

- the capacity for advance warning of environmental threats (e.g., the FAO Global Information and Early Warning System (GIEWS)); and

- the enhancement of public information and awareness (e.g., the World Resources Institute (WRI) World Resources Report and the UNEP Environmental Data Report).

Types of monitoring

Monitoring programmes are mostly sectoral in nature, dealing with forests, desertification, air quality, ozone concentration and the like. Multisectoral and integrated monitoring is, however, receiving increasing attention at the national and international levels (e.g., the European Monitoring and Evaluation Programme (EMEP), the United Nations Educational, Scientific and Cultural Organization's Man and Biosphere Programme (UNESCO MAB) and the United States Environmental Protection Agency's Environmental Monitoring and Assessment Program (EPA/EMAP)).

There are a number of types of monitoring:

- chemical monitoring (e.g., of pollutants)

- physical monitoring (e.g., soil erosion)

- biological monitoring (e.g., status of fauna and flora)

- monitoring of processes and phenomena (e.g., desertification, deforestation, biomass changes)

- monitoring of fluxes and geochemical cycles (e.g., global phosphorus cycle)

- data reconstruction from the past, proxy monitoring (e.g., lake and peat coring, ice cores, tree rings)

- ecological monitoring (e.g., ecosystems, populations)

- socio-economic monitoring and welfare indicators (e.g., infant mortality, gross domestic product (GDP))

- resource inventories (e.g., global forest cover, inventory of land resources)

Monitoring systems

A range of techniques can be used to generate environmental information. Land-based monitoring programmes can comprise the following: total census, area frame sampling (systematic, random, stratified-random), mobile regional monitoring teams, established monitoring networks of fixed stations, questionnaires, spot checks and point samples. Monitoring using remote sensing can employ many of the above data-collection strategies, with its advantage of broader and quicker coverage using satellite sensors and human or automated observers in light aircraft. The GEMS ecological monitoring approach uses three tiers: ground (fixed and mobile sampling), air (low-flying light aircraft) and space (earth resources satellites) (Clarke, 1984).

Satellite systems

Undeniably, the world community benefits from the fact that the cost of satellite systems is borne by a few countries which can afford the enormous research and development (R&D) investment. If it were necessary to pay the real cost, certainly no one apart from researchers in a handful of the richest countries would bother. Despite heavy subsidies, higher-resolution satellite data (either digital or photo products) are not cheap: typically, they cost US$ 2,000-10,000 for a "scene" 100-200 kilometres square, depending on the degree of processing and enhancement required. This is bearable for project-level use, but not for, say, country-wide analyses. Data from a device on the National Oceanographic and Atmospheric Administration's NOAA-x series of satellites, the so-called Advanced Very High Resolution Radiometer (AVHRR), are much less expensive, and produce impressive views of African or even global vegetation. The cost of the data is only a few hundred dollars, and they can be analyzed on relatively inexpensive PC-based hardware/software systems. However, the finest resolution of the AVHRR is a one-kilometre square picture element.

The recent announcement by EOSAT — the commercial vendor of the National Aeronautics and Space Administration (NASA) and for NOAA products — that data older than two years can now be purchased for virtually the cost of copying the computer tape and the medium itself is a significant breakthrough in making the data available to a much wider audience. Perhaps it heralds the day when satellite information on earth resources will be as readily available and generally usable in development activities as, say, four-wheel-drive vehicles.

Data quality assurance

The value of monitoring ultimately rests on the quality of the data collected. Besides having a valid statistical basis and a proven data-collection methodology, any viable monitoring activity must have a quality assurance programme that measures and promotes the reliability of the data collected (e.g., GEMS, Oceans and Coastal Areas Programme Activity Centre (OCA/PAC)). The programme should embrace the whole spectrum of monitoring, from data collection through data analysis to reporting.

Quality assurance (QA) is required to guarantee the generation of data of suitable quality to address the defined aims of the monitoring programme. QA involves a set of activities that ensure the accuracy, representativeness and comparability of data. Besides the production of accurate analytical measurements, a sound data quality programme requires a representative and meaningful sampling programme, a suitable storage and pre-treatment procedure for samples following collection and prior to analysis, and accurate and meaningful data-validation procedures.

QA programmes are supported by the use of reference materials, national and international inter-calibration of the methods and equipment of different laboratories, and internationally standardized methodology development (e.g. GEMS, OCA/PAC). Current QA programmes are carried out in great detail in specific sectors to support the monitoring of, for example, particular air or sea-water constituents. In many cases, training and technical support, including maintenance of equipment, are essential to enable participating countries to comply with the QA standards set for a certain monitoring programme. The cost of these activities means that they are not usually very high on the list of priorities in developing countries.

Data Management

The data and information generated through monitoring programmes need to be stored, analysed, interpreted and presented. The resultant compiled information can then be used for the production of sectoral or multisectoral, topic-specific or integrated assessments. A comprehensive data management system is required.

Sources of environmental data

Data generated by environmental monitoring programmes provide only one source of the information that is required for comprehensive assessments. Other sources include:

- national and international state of the environment (SOE) reporting
- research studies and the resultant open literature, mainly from universities or national research institutes
- regional, national and local studies conducted for a variety of purposes but related to the environment
- remote-sensing satellite systems
- "one-off" resource inventories
- inventories of human activities related to resources (e.g., forest, agricultural and fishery data, FAO) or having an impact on resources (e.g., energy production), including World Bank reports containing basic socio-economic data on all countries in the world
- production/consumption of statistical collections
- standard map-based, atlas-type sources of, for example, topographic, cadastral and hydrological information
- background chemical, physical, meteorological and socio-economic statistics collected by sectoral bodies on a regular or ad hoc basis

When analysing or using data from such sources, it must be borne in mind that the data are often generated using different sampling schemes, scales, recording methods, QA standards and classification systems. More often than not, data derived from different sources are difficult to compare and combine in time series, tabular or spatial analyses.

Moreover, since monitoring programmes are usually sectorally conceived, the data and ensuing assessments they generate often present a narrow view of the true environmental situation. Multisectoral data integration contributes to the provision of comprehensive assessments and the establishment of cross-correlations, and leads to hypotheses of cause and effect. Indications of causes are essential for guiding policy-making and management.

Data management systems

Data derived from different sources can be stored and managed using a range of computer-assisted technologies.

Tabular database systems

The simplest tabular database is an *x*-*y* table. Computerized spreadsheets can store and manipulate very large tables of *x* columns and *y* rows. The manipulation consists of arithmetic, logical or physical (copy, move, fill) operations between rows, columns and blocks of cells. Reports on all or part of the table can be sent to the screen or the printer. Any information that can be quantified — from gross national product (GNP) to elephant birth rates — can be accommodated.

If the features of the spreadsheet are enhanced to include the possibility of constructing and seeking out more complex relations between parts of the table or between the table and other tables, then the system becomes a relational database management system (DBMS). Most popular spreadsheets — for example, Supercalc, Lotus 1-2-3, Quattro — have evolved features which bring their capabilities closer to the common, powerful database management systems, such as dBase, Rbase and Oracle.

Perhaps one of the most important features of a DBMS is that the tedious business of entering the data into the table need be done only once. From then on, a vast number of relationships can be constructed using the command language — or instruction set — of the DBMS. The data can be edited from the DBMS "shell" or modified through in-built calculator features or user-defined sets of rules. Complex models can be constructed and run to test countless hypotheses and altered assumptions without compromising the integrity of the database itself.

Management information systems use a DBMS that has been specially tailored to track the efficiency, output and project status of a particular corporate operation.

Bibliographic and referral database systems

Bibliographic and referral systems are database management systems which point to information in the literature or in specialized sources (e.g., laboratories and agencies). Many, such as FAO's Forest Information System (FORIS) and Biological Abstracts, are subject-specific. Others cross-reference a range of sources, such as UNEP's International Referral System on the Environment (INFOTERRA), and the UN's Agency Coordinating Committee Information System (ACCIS). Some are commercial and most appear to be in the public domain. The expense occurs in accessing the systems through a telecommunications server, such as The Source or Compuserve.

Spatial database systems

With the need to integrate data and produce maps to guide operations on the ground (e.g., city planning), geographic information systems (GIS) began to be developed in computer environments in the 1960s. However, a GIS is not only a producer of maps — computer-aided drafting and cartography do that well enough. GIS can be used to combine and manipulate spatially referenced information to produce new information, which is also spatially referenced. For example, the cell in a DBMS table tells "how much" or "of what type." Since a GIS is usually coupled to a DBMS, a polygon generated by a GIS can not only be linked to this "how-much/what-type" information, but can also map where on the earth's surface those conditions occur. By answering the questions what and where, GIS brings the user one step closer to action.

There are two generic sorts of GIS: vector and raster. Vector systems use topological manipulations of points, lines and polygons to build spatial relations. Raster systems use *x*-*y* grids of geo-referenced numerical data to build composite "pictures," like a TV screen, which is, in fact, a raster display unit. Vector systems are particularly good for manipulating conventional map data, while raster systems lend themselves to the analysis of satellite data.

The power of GIS to integrate data from disparate sources using different classification systems (e.g., tables, maps, satellites) by means of the common denominator of geographical location, makes it particularly useful for complex environmental assessments. UNEP's Global Resource Information Database (GRID) system uses both vector (e.g., ARC/Info) and raster (e.g., Earth Resource Digital Analysis System (ERDAS), Land Analysis System (LAS), ELAS, IDRISI, Spatial Analysis System (SPANS)); the European Community's Coordination of Information in the Environment (CORINE) and the UNEP/World Conservation Union/World Wildlife Fund (IUCN/WWF) World Conservation Monitoring Centre use ARC/Info.

Information system components

The various types of data management systems mentioned above have certain common operational elements which must be considered irrespective of the type of system. Although designed to enhance the tractability and usability of information, these elements often add to the complications of integrating information.

Classification systems

There are nearly as many methods of classifying types of information attributes as there are workers doing the classifying. Thus, there are no universally accepted systems of classifying soils, vegetation and landcover in environmental fields today. This is partly because such phenomena do not lend themselves to simple statistical expressions (e.g., densities per unit area or numbers per capita) and partly because the original classifiers often had different objectives in mind.

Data centres

There is a tendency to house data in centres. In part, this is a throwback to the days when ledgers needed lots of dry shelving and when, later, adequate computer power meant huge machines in large, air-conditioned rooms. Today, the main reasons left to justify centres are organizational: there needs to be a central responsibility for standardized and reliable data input, storage, back-up and updating. With increasing power and decreasing costs of computers, decentralization of work stations and portions of the databasing responsibilities becomes feasible. The World Data Centres for meteorology in Washington, Melbourne and Moscow have set a pattern for decentralization which is being picked up, for example, by the growing network of GRID centres (e.g., in Nairobi, Geneva, Arendal, Sioux Falls and Bangkok).

The role of data centres is thus changing in emphasis from being points of concentration to becoming points of dissemination, and, in time, the management of distributed networks will become the rule rather than the exception. The same development will be seen at both the national and the international levels. Thus, national bureaus of statistics will become, we predict, national mechanisms for information exchange.

Communications

Information is exchanged by word of mouth (or body language), on paper (text or graphics) or electronically (voice, text, graphics, video). The technology of electronic data exchange is just beginning to move out of the entertainment/news media realm to that of data. Faxes are ubiquitous, and information "on line" is practically commonplace for those who have access to a telephone, a properly configured computer and money to pay for system access. On-line databases (such as Biological Abstracts or the Official Airline Guide in the private sector and INFOTERRA and the International Cleaner Production Information Clearinghouse (ICPIC) in the international public realm), higher-level communication services (such as Dialog and The Source (commercial) and Greenet (public)), and the communications systems they access (such as Bitnet and Telenet) lend themselves primarily to the sending and receiving of textual or tabular data via commercial telephone services. In theory, any computerized data can be transmitted as bits in binary form. Transmission rates are limited primarily by the rules of postal and telecommunications authorities and the speeds at which commonly available modulator-demodulator devices ("modems") can transform and transmit data over telephone lines. There are no technical reasons why data cannot be sent two or three orders of magnitude faster than at present.

Such data exchange modalities demand a certain conformity — for example, ASCII text (strings of formatless alphanumeric characters) or 7-bit computer "words" — in order to ensure that the computer at the other end does not interpret what it receives as gibberish. Despite their proprietary internal methods of data organization, most software systems can output to standard text formats, so that a word-processing system can "pick up" information from a spreadsheet system and vice versa. There is, in short, little impediment to virtual universal data exchangeability.

Metadatabases

The proliferation of databases has lead to the development of so-called "metadatabases," which are databases containing information on data. UNEP's INFOTERRA is, in part, such a system; it does not provide the data themselves, but rather information on the sources that contain the data. Similarly, the World Health Organization/European Office's (WHO/EURO) Environmental Health Information System points to external sources. GRID is developing a metadatabase to keep track of its own spatial data holdings. The German-supported UNEP office for the Harmonization of Environmental Measurement is developing a metadatabase on existing monitoring and assessment information, the programmes which generated it, their mode of operation and their reporting structure.

Development of indicators

Data-integration efforts are under way to enhance the usability and the ease of interpretation of environmental data and information (see also Theme Paper Three). Two of these data-integration techniques are briefly outlined below.

Environmental indicators:

Environmental indicators are currently under development (e.g., by the World Resources Institute (WRI), the Organization for Economic Co-operation and Development (OECD) and other institutes) that will allow environmental information to be integrated and presented to policy-makers in a format suitable for their requirements. However, the need for validation of the indicators should be stressed: indicators must be field-tested prior to promotion for wide use. Extreme care should be exercised in using indicators to rank countries' contributions to specific pollution problems, or for country-specific weighting (e.g., with regard to population, GNP, industrial development, production and consumption).

The construction of environmental indicators may be predicated on the following information flow:

- conditions in the field
- generation of environmental data through techniques such as monitoring and remote sensing
- validation, analysis, compilation and evaluation techniques
- indicator derivation
- indicator validation by field-testing
- promotion of indicator use

Biological indicators:

Biological measurements often give a well integrated indication of the pollution and environmental stress experienced by different ecosystems. Inasmuch as it measures organisms' responses to changes in their environment, biological monitoring can provide information on the integrated, end-point effects of environmental conditions and contaminants. An example is the Intergovernmental Oceanographic Commission (IOC)/ UNEP Global Mussel Watch programme. In the 21st century, there will be an increasing need to have a set of sensitive sentinels, or "global pit canaries," to provide indications of environmental degradation or improvement in the ecosystem as a whole (e.g., freshwater resources, urban environments, forest health).

Assessments

An environmental assessment is the end point of the data-collection and data management process. Policy decisions and management action require more than tables and graphs: there must be informed interpretation as well. Most assessments are still done by expert analysis: individuals or groups synthesize and interpret the available information in a classical procedure of review, analysis, consensus and reporting. Comprehensive assessments cannot be done by those who monitor and those who handle the data alone. They must be done in close partnership with the sectoral experts who are ultimately responsible for the scientific basis of the information collected.

Compiled and validated information is increasingly being evaluated by human experts using computer-assisted techniques, such as statistical analysis, GIS (for combining and analyzing spatially related information), simulation modelling, scenario development (using any of the foregoing techniques) and expert system procedures. Expert systems use artificial intelligence techniques to incorporate heuristic knowledge — sets of rules created by subject-matter experts — into procedures for interpretation, prediction and decision-making. Although the use of such "knowledge-based" techniques in environmental assessment is still new, the incorporation of human knowledge through rule-based reasoning for statistical, numerical, non-numerical and spatial analyses will undoubtedly add a new dimension to the management of natural resources, at both the national and the global levels.

There is increasing pressure on environmental assessors to take the process as far as possible, working with sectoral experts to develop packages of management options for the decision-makers, who will have the ultimate responsibility for drafting legislation, altering policy and deploying management troops in the field.

Monitoring and Assessment for Decision-making

It is impossible within the scope of this paper to review all major ongoing monitoring activities. A list of publications describing major monitoring programmes is provided in Annex II. To illustrate the link between monitoring and the policy making process, a selection of ongoing monitoring programmes will be reviewed briefly in the following paragraphs.

Global Programmes

Global monitoring programmes are relatively few in number. It appears that comprehensive international-level assessments can only be obtained in a selected number of cases where sufficient information exists. Even at the national level, comprehensive assessments have often been hampered either by a lack of information or by the inability to integrate it. Therefore, global assessments on a particular topic of importance should be made at regular intervals, as longer time series and better quality monitoring data and research results become available and as political circumstances change. Only then will it be possible to follow environmental changes over time, establish the nature of the trends, and obtain an indication and understanding of the causes of those trends for all major environmental issues.

Global environmental monitoring is currently inadequate in terms of providing policy-makers and environmental managers with the information they need for the sustainable development of natural resources and the prevention of pollution. Our view of the state of the environment is deficient in most areas. The gaps in knowledge can only be filled by a better definition of what type and amount of information global monitoring should provide, and by a clear understanding of what is needed and what is possible. This should involve a logical chain of coherent requests. Ideally, the decision-maker should say to scientists and analysts: "I need information here and there." The scientist should say to the technicians and data producers: "Give me information on this and that." But such dialogues take place only rarely; each group remains more or less in the dark about what the others really need and what they are capable of producing or absorbing.

Data compilation on a global scale from disparate sources occurs quite often. FAO, for example, compiles annual data on land use, production and trade in areas such as agriculture, livestock, forestry and fisheries. GEMS/MARC (Monitoring Assessment Research Center) compiles global data in biennial Environmental Data Reports, while the UN Statistical Office (UNSO) publishes the Energy Statistical Yearbooks. Data on population appear in the Demographic Yearbook and in different publications of the UN Population Division. The International Register of Potentially Toxic Chemicals (IRPTC) collects data on many aspects of dangerous chemicals, including legislation; WCMC monitors endangered species and the protected areas of the world; and GRID stores globalmap-based and satellite-derived data, both in static form and in time series (e.g., global vegetation index). The WRI report is a major compilation and review of a range of environmental topics.

The following two examples illustrate how global environmental monitoring and assessment have been successfully applied in the international decision-making field, leading from assessments to negotiations on a convention.

The Intergovernmental Panel on Climate Change

In 1985, with support from UNEP and WMO, and working under the Scienfitic Committee on Problems of the Environment (SCOPE) programme of the International Council of Scientific Unions (ICSU/SCOPE), the International Meteorological Institute in Stockholm prepared an assessment of actual knowledge concerning the problem of climate change caused by increasing greenhouse gases in the atmosphere. In continuation of this scientific assessment, UNEP, in co-operation with the Stockholm Environment Institute, convened a meeting in Villach and Bellagio in 1987 to consider the socio-economic and political implications of the increase in greenhouse gases and the political options for adapting to or limiting their effects.

In November 1988, as a consequence of the above activities, WMO and UNEP established the Intergovernmental Panel on Climate Change (IPCC) to follow up on the earlier assessments at the scientific, environmental impact and political levels. The IPCC report was published in August 1990. It was reviewed by the WMO/UNEP/UNESCO/FAO Second World Climate Conference in November and adopted by the United Nations General Assembly (UNGA) in December 1990.

As a follow-up to the report, UNGA set in motion a governmental negotiation process on a climate convention, starting in Washington, DC in February 1991. A special secretariat for this process will be established in Geneva. The success and effectiveness of a future climate convention is to depend largely on the provisions made for developing countries. Action to strengthen their capacity to collect and analyse climate-change data, assess the impacts of climate change and identify response options is a necessary prerequisite.

The IPCC process described above, from assessments — in the Earthwatch context — to negotiations on a convention, is a good example of how an integrated assessment process involving UN agencies, international scientific organizations and governments should operate.

The ozone problem

In 1977, following the scientific disclosure in 1974-75 that chlorofluorocarbons (CFCs) emitted into the atmosphere could endanger the stratospheric ozone layer, UNEP convened a meeting of international experts to discuss what mitigating activities should be undertaken under Earthwatch. The decisions of this conference led to the creation of the Coordination Committee on the Ozone Layer. From 1979 to 1985, this Committee was in charge of a continuously evolving assessment process that resulted in the annual publication of a reporton findings in the area and, in 1985, of a comprehensive assessment report. The assessment process led, in turn, to governmental negotiations for a convention on the ozone layer, which was adopted in Vienna in 1985.

As new evidence of the harmful effects of CFCs and related substances on the ozone layer became available, UNEP called a further meeting in Montreal in 1987. That conference adopted a first protocol to the Vienna convention on gradual prohibiting of emissions of CFCs. Activities aimed at strengthening this protocol are still going on, co-ordinated by the Secretariat for the Ozone Convention within UNEP in Nairobi. The ozone depletion issue is another successful example of the Earthwatch process, albeit one which was initiated almost by chance.

Regional Programmes

Regional monitoring programmes are usually geared towards specific regional problem areas. Regional organizations tend to tailor their monitoring programmes, data assembling and reporting efforts to the particular realities of their members. For this reason, data assembled and reported in one region might not be of relevance in another. Examples of regional monitoring and data compilation and assessment programmes include the Economic Commission for Europe (ECE) forest statistics, OECD pollution flows and the EMEP and NAPAP programmes.

In a number of these programmes also, the monitoring process has led to the development of control policies and to the formulation of, or amendments to, international conventions.

Convention on Long-range Transboundary Air Pollution

During the late 1970s, the European Monitoring and Evaluation Programme (supported by the ECE, WMO and UNEP) set up a co-ordinated air-pollution monitoring network in Europe. This network provided the basic data that served as background for the development of the Convention on Long-range Transboundary Air Pollution, which came into effect in March 1983.

In 1984, evidence of declining forest health reported by many European countries led to the establishment of the International Co-operative Programme on the Assessment and Monitoring of Air Pollution on Forests. This programme was launched in 1985 under the Convention on Long-range Transboundary Air Pollution. Since 1986, the programme, supported by UNEP, has produced annual surveys on forest damage in the ECE region.

UNEP Regional Seas activities

Under the auspices of the UNEP Oceans and Coastal Areas Programme Activity Centre and in co-operation with numerous specialized agencies and organizations (including FAO, the International Atomic Energy Agency (IAEA), the International Marine Organization (IMO), IUCN, WHO, WMO and UNESCO/IOC) assessments of the environmental status of regional seas and coastal areas have been carried out in many parts of the world, starting with the Mediterranean in 1974. Numerous national and regional reports on the state of the marine and coastal environment have been published, and have provided the basis for Regional Seas action plans and management measures to control the problems identified. Regional marine-pollution assessment and control programmes have been organized to identify and correct critical pollution problems, and national and regional contingency plans have been developed to respond to marine-pollution emergencies. The effective implementation of these measures involves a painstaking process of capacity-building, so that all coastal States — particularly the developing countries — can achieve effective management and sustainable development of their coastal areas and resources. UNEP and IOC have also organized regional task teams to prepare assessments of the effects of predicted climatic changes and sea-level rises in coastal areas.

The African elephant database

The compilation of all existing African elephant data within UNEP's GRID began in 1986 as a co-operative effort by the European Economic Community (EEC), WWF and the Elsa Foundation at UNEP in Nairobi. The analysis using GIS allowed for both the modelling of population densities outside of survey areas and the analysis of environmental and socio-economic constraints on the population. This status-trend assessment was brought to the attention of the European Parliament and

led directly to the altering of the status of the species within CITES and the resultant world-wide ban on ivory trade in 1989.

National Programmes

The extent to which national monitoring programmes are conducted varies widely in different regions of the world. Developed countries often have many extensive, and sometimes overlapping, monitoring activities. For example, in Japan, air-pollutant concentrations are monitored hourly at 1500 stations. On the whole of the African continent, however, only a few air-quality monitoring stations are operative.

Monitoring programmes are conducted in the industrialized world by a multiplicity of organizations: national, regional and local government authorities, universities and research institutes, non-governmental organizations (NGOs) and the like. Donor support is the rule, more often for the establishment of programmes than for their long-term operation.

Most national-level monitoring activities are sectoral and are determined by the priorities of the country in question. Data are collected in response to specific policy questions and the exigencies of reality. This invariably leads to skewed data availability: abundance in one area, deficiency in others.

Comprehensive overviews of the national environmental resources and situation are found in the state of the environment (SOE) reports. In a "shot-gun approach" reminiscent of that used for the 1972 Stockholm conference, the production of SOE reports from *all* countries has been set in motion by the preparatory process leading up to the UNCED conference.

Increasing numbers of governments — albeit mainly those in the industrialized world — are establishing long-term monitoring programmes on major critical environmental issues, sometimes according to internationally agreed procedures and within an international framework. Issues covered by national monitoring programmes include human population, health and energy use; flows of anthropogenically created materials; the state of air, land and water; the status of the biosphere, living organisms and their habitats; land use and misuse; resource extraction and refinery; ocean exploitation; threats to coastal areas; and the use of freshwater. Socio-economic indexes are also covered by most national governments, particularly in the more industrialized countries.

Regional and global assessments often depend on data collected through national monitoring networks. Therefore, countries need to harmonize their national monitoring and assessment methodologies. Examples of the successful standardization of data collection, analysis and reporting procedures among many different countries — making it possible to compile information for global and regional assessments — can be found in the World Weather Watch (WWW). Co-ordinated by WMO, the WWW is successfully collecting, assembling and disseminating data on the state of the atmosphere through its Global Telecommunications System and a network of national meteorological stations, and is supplemented by an international network of observing systems based on ground, air, sea and in space.

International Responses

There are a number of ongoing programmes which, either explicitly or implicitly, are aimed at contributing to the international co-ordination of environmental monitoring and assessment.

Earthwatch

Earthwatch is the environmental monitoring and assessment arm of the United Nations. Established in 1972 by the United Nations Conference on the Human Environment, it is co-ordinated by UNEP in accordance with the mandate conferred on it by the United Nations system. Earthwatch was established to:

- identify and assess major environmental problems;
- continually review the world environmental situation in order to ensure that emerging environmental problems of wide international significance receive appropriate and adequate consideration by governments; and
- promote the contribution of relevant international scientific and other professional communities to the acquisition, assessment and exchange of environmental knowledge and information and, as appropriate, to the technical aspects of the formulation and implementation of environmental programmes within the United Nations system.

Over two decades, the use of environmental information evolved, moving from an emphasis on *qualifying* problems to *applying* information in policy-making at all levels of society. To reflect this shift, the mandate of

Earthwatch had to be revisited. Accordingly, at its 1982 Session of Special Character, the Governing Council (GC) of UNEP reviewed the major achievements in the implementation of the Action Plan for the Human Environment adopted by the Stockholm Conference and decided that the basic orientation of the Earthwatch Programme for 1982-1992 would be to:

- improve early-warning indicators of significant environmental changes;
- improve the planning and co-ordination of monitoring at the global and regional levels;
- produce concrete assessment statements for important environmental problems and their human health, social and economic implications; and
- promote the establishment of reliable global, regional and national environmental statistics and state of the environment reporting as a basis for evaluating major trends and deciding on any necessary action.

In 1988, these guidelines were incorporated into the System-Wide Medium Term Environmental Programme (SWMTEP) for the period 1990-1995. SWMTEP elaborated further on the objectives of Earthwatch, which were to:

- accumulate and improve reliable and comparable scientific and technical information about environmental issues, and develop and apply a means of collecting, storing, retrieving and processing such information that will make it readily available to decision-makers and specialists; and
- provide comprehensive assessments of environmental issues on the basis of socio-economic data and data on the major components and processes of the global and regional environments, in order to appropriately monitor the transition towards sustainable development.

In 1989, the UN General Assembly reaffirmed the role of Earthwatch in the development of criteria for the identification of environmental threats at the national, regional and global levels, and in the production of authoritative assessments to anticipate environmental degradation and to issue early warnings to the international community. Consisting of research, evaluation, monitoring and information-exchange activities, Earthwatch is thus conceived to be a dynamic process of integrated environmental assessments by which relevant environmental issues are identified and necessary data are gathered and evaluated to provide a basis of information and understanding for effective environmental management.

The Global Environment Monitoring System (GEMS) is the monitoring arm of the UN system-wide Earthwatch branch, co-ordinating and catalysing global and regional environmental monitoring programmes within the UN system. GEMS's mandate is to provide the world community with the scientific data required for the rational and sustainable management of the environment.

GRID, another programme element of Earthwatch, is designed to provide the world community with timely access to geo-referenced environmental data and to improve, harmonize and support the use of GIS and associated data management technologies at the national, regional and global levels. GRID, in close co-operation with GEMS/PAC and the United Nations Institute for Training and Research (UNITAR), is playing a catalytic role in providing national governments with the capability to rationally handle, analyse, store and display their geo-referenced environmental data and related, relevant information. Increasingly, governments are using basic geo-referenced datasets on such national characteristics as soil types, catchment areas, forest reserves and land-use patterns for the rational management of their resources.

GRID is also addressing the question of access to environmental data in forms readily usable by scientists and policy-makers world-wide. The aim is free and open access, eventually in a global system that works as simply as a telephone network.

Other important components of Earthwatch are the International Register of Potentially Toxic Chemicals (IRPTC), the International Referral System (INFOTERRA) and the International Programme on Chemical Safety (IPCS).

IRPTC's mandate is to serve as an essential tool in optimizing the dissemination of information on chemicals and their use for human well-being, while at the same time providing a global early-warning system on undesirable environmental side effects of potentially toxic chemicals. As a co-operative and decentralized network of national focal points and information sources, INFOTERRA serves as an international source of environmental information. IPCS provides toxicological assessments for an increasing number of substances, guidelines for emergency response to chemical accidents and technical co-operation in the control of toxic chemicals.

Earth Observation System

The new multi-million dollar Earth Observation System (EOS) of NASA in the United States consists of a space-based observation system, a data and information system and a scientific research programme. It represents the initiation of a comprehensive, global observation system with broad and high-resolution spectral and spatial, as well as long-term, coverage of the Earth. EOS will be complemented by companion European and Japanese platforms, as well as by existing earth resources satellites. EOS will provide the first co-ordinated simultaneous measurements of the interactions of the atmosphere, oceans, solid earth and hydrological and biogeochemical cycles. It will help to relieve the long-felt frustration of researchers who have to squeeze information out of data generated by satellites that were designed for something other than natural-resource monitoring and assessment.

Global Environment Facility

The Global Environment Facility (GEF) represents an agreement by a group of participating countries to establish a Trust Fund within the World Bank to fund programmes (implemented by UNEP, UNDP and the Bank itself) aimed at promoting sustainable development and protecting the global environment and resource base. GEF is a pilot programme under which concessional loans will be granted to developing countries to help them implement programmes, including those for monitoring and assessment, that protect the global environment. Four areas have been identified for GEF's operations: protection of the ozone layer, limitation of greenhouse gas emissions, protection of biodiversity, and protection of international waters.

Intergovernmental Panel on Climate Change

A vast body of experience and knowledge exist in the research community. In the field of climate change, this knowledge is being pulled together for the first time on a global level by the Intergovernmental Panel on Climate Change (IPCC) to provide the world with a comprehensive overview of climate-change related issues (see page 15).

IPCC is sponsored jointly by WMO and UNEP. Three working groups compiled available information on the scientific aspects of climate change, on the potential impacts of climate change and on the possible policy response strategies.

International Geosphere and Biosphere Programme

An interdisciplinary research endeavour carried out within the framework of the International Council of Scientific Unions (ICSU), the International Geosphere and Biosphere Programme (IGBP) is focused on a set of key environmental research questions that relate to ocean-atmosphere interactions, biosphere-atmosphere interactions, paleo-climate changes, and design and development of observation and data management systems. Along with WMO's World Climate Research Programme (WCRP) and other international research efforts, IGBP addresses critical "unknowns" related to global environmental changes.

UN Conference on Environment and Development

In preparation for the 1992 UN Conference on Environment and Development (UNCED), efforts are under way in all major environmental fields to review the successes and failures of environmental monitoring and assessment in the last 20 years and to draft action plans for the coming decades — the so-called "Agenda 21." For example, water is emerging as one of the most critical global issues for the immediate future. Within the international freshwater community and in the framework of the Mara del Plato Action Plan, a concerted global action plan that is both economically viable and environmentally acceptable is under preparation for the sustainable management and development of freshwater resources.

Programme on Environmental Information Systems in Sub-Saharan Africa

In response to increasing donor frustration at the duplication of development efforts — particularly in the realms of collecting and compiling environmental information, training and the establishment of national capabilities — the Environment Division of the World Bank's African Regional Office regularly convenes a Steering Committee for a Programme on Environmental Information Systems in Sub-Saharan Africa. The committee comprises UN development bodies (including the World Bank, the United Nations Development Programme (UNDP) and the United Nations Statistical Office (UNSO)), UNEP/GRID, a number of bilateral aid bodies that work in Africa, and some African national agency representatives. The primary aim is to provide a forum for the exchange of information, the examination of possibilities for joint programming and, ultimately, to

achieve development interventions in Africa that are more efficient and that avoid duplication.

Issues and Propositions for the 21st Century

General

Proposition: The assessment process, in which monitoring plays an important part, is clearly imperfect, since 20 years after Stockholm, we do not yet have comprehensive assessments in all sectors.

Ideally, monitoring and assessment systems should be at the interface between the environment and development, providing the bridge between science, policy and action. They should provide a mechanism for determining whether development is sustainable or not. They should define the limits to certain kinds of human activity on this planet, and issue warnings when those limits are approached or exceeded.

Meeting environmental information requirements for the 21st century will require work in three arenas:

- in the industrialized world, where large amounts of environmental data are often available, but usually in forms that are not comprehensive or of direct relevance to policy-makers (due, among other things, to their sheer volume);
- in the developing world, where basic data on the state of the environment often are not routinely available, hampering not only an evaluation of the situation at the national level, but also the understanding of how national environmental problems influence and contribute to constraints on development at home and to regional and global issues; and
- in the global forum, where international co-ordination is of paramount importance if the challenges of global change and a global resource commons are to be met.

Proposition: Data generation and information handling must accompany every step of environmental and resource policy, management and development.

It can be foreseen that in the 21st century, information will be increasingly required to ensure compliance with control measurements, international agreements, national and regional laws and the like. However, the information-gathering and analysis systems used for these purposes have not yet received sufficient attention. The following information flow, which echoes Earthwatch's early concepts, may be envisaged:

- monitoring network: initial samples for describing the state [of things]; repeated measurements for trend analyses
- assessments, advanced warnings of threats
- guided management interventions, international agreements
- repeat monitoring: status/trends as affected by management, and international agreements

Global problems call for strong concerted global monitoring programmes. However, there is often a lack of international consensus on monitoring and assessment objectives, on what data should be collected, how they are to be collected, who should do the collecting and analysis, where they are to be assembled and stored and how the information is to be disseminated.

Proposition: International or intergovernmental co-ordination of monitoring and assessment is required at both the planning and implementation levels.

Few environmental problems have yet reached proportions that have alerted the global community and led to international action. Two notable exceptions are familiar to everyone: the increase in greenhouse gases and the depletion of the stratospheric ozone layer. There are other potential global problem areas which warrant international attention: contamination of freshwater resources; loss of biodiversity, forests and productive soils; coastal zone impacts; contamination of regional seas; transboundary movement of hazardous wastes; and Antarctica.

Proposition: The serious environmental problem areas are universal in scope and it can be predicted that they will require concerted international action now or in the very near future.

Data Issues

Increasingly, natural resource accounting and costing of environmental degradation is becoming an integral part of development-related activities. The inclusion of data pertaining to the environment in established socio-economic data reports — for example, those produced by international organizations such as the World Bank, UNESCO and the OECD — reflect the increasingly

important role of the environment in all aspects of social and economic life.

Proposition: The implicit demand for data from development assistance institutions needs to be met in a co-ordinated fashion.

Information for policy-making requires data from organized and systematic measurements that are consistent and comparable, temporally as well as spatially. Data obtained by observation and measurement of any environmental variable can only provide a partial and transient indication of the state of the environment. Furthermore, issues associated with international data comparability — for example, data validity, quality assurance, standards of production and use, and consistency and timeliness in data reporting and documentation — often do not receive adequate attention internationally.

Proposition: Necessary and sufficient international data uniformity and compatibility must be assured, and the integration of data quality measures must be promoted to strengthen environmental problem-solving at all levels.

Sectoral constraints

Proposition: Sectoral databases are seldom integrated to give a comprehensive assessment of the environmental situation.

Monitoring systems are usually sectorally spawned. This creates fundamental difficulties in integrating information to describe, model and understand how the real world works. The lack of integration of different national, regional and global activities sometimes leads to duplication of isolated efforts, as is seen, for example, in the field of urban environmental monitoring, assessment and management. Another problem is that monitoring is often conducted on an *ad hoc* or occasional basis and uses different instrumentation and methodologies, which makes comparison between different datasets nearly impossible.

Regional constraints

Proposition: Data that are assembled and reported in one specific region may have little or no value for third-party use in interdisciplinary or global problem-solving. However, the methodologies might be transferable.

Regional programmes tend to be tailored to the specific needs of the countries participating, and their methodologies, data assembling and reporting efforts are adapted to their members' particular requirements.

Proposition: Monitoring programmes need international support for integration at the national, regional and global levels.

Sooner or later, many of the same environmental problems that occur in one region are bound to occur in others. Regional action plans for the environment (for example, within the framework of sub-regional mechanisms like the African Ministerial Conference on the Environment (AMCEN), the Caribbean Action Plan (CAP) and the South Pacific Regional Environment Programme (SPREP)) can help extend the coverage of regional programmes to all parts of the globe. Efforts are thus under way to further integrate different regional programmes dealing with similar problems, in order to obtain a global overview of the situation (as, for example, in the UNEP/ UNESCO/WMO programme of Global Integrated Monitoring).

Geographic scope

Proposition: In most developing countries, the lack of resources and technical capacity, combined with pressing demands to meet basic human needs, makes monitoring a low priority.

The distribution of available data is heavily biased in favour of the North. Regional monitoring programmes are often confined to the industrialized world, leaving major data holes and gaps in our knowledge of the state of the environment in developing countries. Similarly, global monitoring programmes seldom provide data of universal coverage. Most global and regional assessments depend largely on national monitoring stations, which are patchy in distribution when viewed on global or regional scales and often use different methodologies. Data compilation at supra-national levels is therefore difficult.

Subject-area needs

A number of international efforts (e.g., those within the European Economic Community (EEC), and the OECD, and by IGBP and Earthwatch) to develop criteria for the identification of priority environmental threats at the national, regional and global levels and to compile priority lists of issues that require global environmental monitoring are currently under way.

Proposition: Monitoring systems need to accommodate not only many more known issues, but also "surprises" and emerging issues which will undoubtedly come to the fore in the future.

Monitoring and assessment initiatives are urgently required in the areas listed under each of the following protection or conservation objectives:

- **Protection of the atmosphere by combating climate change, depletion of the ozone layer and transboundary air pollution:**

  — production system changes
  — sea-level rise
  — depletion of stratospheric ozone
  — impact of UVB rays
  — acid deposition

- **Protection of the quality and supply of freshwater resources:**

  — pollution, including transboundary pollution
  — supply issues
  — hydrological cycle manipulation

- **Protection of oceans and all kinds of seas (including enclosed and semi-enclosed seas) and coastal areas, and the protection, rational use and development of their living resources:**

  — global marine pollution
  — eutrophication and bacterial/chemical pollution of regional seas
  — impacts on coastal areas
  — living marine resources

- **Protection and management of land resources by, *inter alia*, combating deforestation, desertification and drought:**

  — soil loss
  — desertification
  — deforestation
  — ecosystem modification
  — impacts of irrigation

- **Conservation of biological diversity:**

  — loss of biological diversity
  — loss of species and habitats

- **Environmentally sound management of bio-technology:**

  — impacts on ecosystems

- **Environmentally sound management of hazardous wastes, particularly hazardous wastes of toxic chemicals, as well as prevention of illegal international traffic in toxic and dangerous products and wastes:**

  — waste disposal practices and impacts
  — sources, distribution and impacts of chemical substances and processes

- **Protection of human health conditions and improvement of the quality of life:**

  — urban/rural habitats
  — impacts of population growth
  — health effects
  — human welfare indicators

The list is clearly not exhaustive. Virtually all of the above categories suffer as much from lack of data as from the lack of an appropriate global monitoring system. The two, of course, are intimately linked.

Proposition: Information and monitoring requirements for modelling, prediction and validation of models — particularly with regard to global change and transboundary pollution issues — need to be formulated clearly.

The contemporary flurry of programmes related to global change — IGBP, IPCC, International Space Year, etc. — are both welcome and necessary to increase understanding of the processes of global change. The specific data requirements of such programmes are not yet fully articulated, nor is there yet agreement on reducing the duplication of data-collection efforts between such programmes.

Proposition: Internationally selected expert and modelling groups are required to assist in programme implementation and data evaluation, and to provide forecasting and early-warning capabilities to assessment programmes.

Although the responsibility for data handling, storage and dissemination can be carried out most efficiently by data specialists, such as those within GRID, the ways in which the data are analysed and the conclusions and assessments drawn from them must be determined under the guidance of sectoral experts.

Quality assurance and standardization

Proposition: Extensive and often costly international co-operation is needed to support and guide national activities.

Global networks need to be supported by quality assurance (QA) programmes. Because environmental monitoring programmes deal with our common natural heritage, standardization of measurements taken by national monitoring programmes using internationally accepted guidelines and protocols is essential, if only to avoid investment in methodological problems that have already been solved elsewhere. This standardization should cover such areas as sampling strategy, analytical procedures, quality assurance, data analysis and reporting, modelling and simulation, and standard and critical load-setting. Again, recent years have seen different and often disparate efforts in this regard, including the International Standardization Organization (ISO) guidelines produced by the UN Statistical Office or international agencies, and handbooks associated with regional programmes.

Proposition: Additional support is required for technical co-operation, particularly in developing countries and in newly emerging democracies, in support of global and regional assessments.

Quality assurance and technical support programmes that include training, equipment maintenance and calibration are often more efficiently organized within a regional framework, even when they pertain to global programmes. Examples of programmes conducting regional quality assurance and technical support include EMEP, GEMS/AIR and UNEP's Regional Seas programme. Mobile regional auditing teams are often used to implement essential programme components, such as equipment calibration and maintenance, data validation and on-site training.

Proposition: A well established international mechanism for a standard reference material production, distribution and evaluation system within GEMS is necessary.

In order to ensure compatibility of different datasets in terms of supporting international and national monitoring programmes, it is necessary to have standard reference materials composed of "knowns" for calibration and "unknowns" for checking purposes. These are not yet available to the extent required for global data compilation across a range of sectors.

Proposition: The approach of reducing classification systems to easily measured common denominators should be examined in other sectors.

Although a daunting prospect, international agreement on the harmonization and use of common classification systems for environmental resources and processes should be encouraged and supported. For example, the International Soils Reference Information Centre is examining the approach of reducing the various extant soils classification systems to common denominators based on fundamental physical parameters.

Time factors

Proposition: Long-term monitoring is a worthwhile investment.

Data collected by national programmes are often needed to support a specific assessment objective and are therefore not gathered over prolonged periods of time. This makes the development of time series and the following of trends difficult. In addition, global issues often involve processes that might be invisible at present and take decades to become obvious. An example is the accumulation of radiatively active gases — the so-called "greenhouse" gases — in the atmosphere. If the world had begun to monitor carbon dioxide concentrations only five years ago, today there would be arguments about whether the observed increases were real or significant. Too often, the absence of knowledge of change is perceived as the functional equivalent of the absence of change.

Proposition: There is a need for an internationally operated and subsidized network for rapid delivery of satellite data.

During the recent crisis in the Middle East, GRID-Geneva was receiving digital satellite data from GRID-Sioux Falls (located within the US Geological Survey (USGS) EROS Data Centre) almost as soon as they were available via telecommunications. By contrast, the processed film products arrived with a lag of approximately three weeks. The FAO's African Real Time Environment Monitoring Using Imaging Satellites (ARTEMIS) system can receive NOAA satellite data almost as they are beamed down, and can process them and pass them on for early-warning purposes within hours. But GRID and ARTEMIS are rather special high-technology operations. Unless one has a satellite-receiving station virtually on one's roof or a high-speed communications link, the delivery of earth resources data to the average international, non-North American user can take weeks, even months.

Technology Issues

Information systems

Proposition: It is necessary to strengthen internationally co-ordinated efforts aimed at collating, storing and distributing environmental information, and at promulgating appropriate information-handling technology.

There exists an abundance of information systems, large and small, public and private. It will never be possible to get everyone in the world to use one standard system, nor would this be wise, given the necessity for sectoral experts to continue contributing to information-generation within their own sectors. The extent of exchange between systems, and therefore between sectors, is currently limited. However, such exchange is essential for integrating data, doing assessments and developing policy options.

Proposition: A globally accepted information-exchange and distribution system on monitoring and assessment methodologies and existing data sources should be set up — for example, within UNEP's HEM centre in Munich — along the lines of other global information dissemination systems, such as IRPTC and INFOTERRA.

The fact that good information exists *somewhere* is of little help when one does not know where to find it. The proliferation of information and information systems cannot be stopped; indeed, it should be encouraged. In order to make them optimally useful and to achieve maximum returns on large investments of public money, more effort needs to be exerted at the international level regarding the development of information systems about information itself; that is, the development of so-called metadatabases.

Proposition: Geographic information systems, with their ability to integrate information from different sectors using the common denominator of geographical location, as well as their increasing availability and tractability, show great promise in achieving cross-sectoral data integration.

Most global environmental databases still lack the capability to extract and combine sectoral information in a format that can be used for predicting and assessing the impact of specific investment and development projects. The need to be able to predict and assess these impacts should, amongst other factors, determine the structure, management and access rules of the databases.

Proposition: There is a need to provide further attention and research and development (R&D) support to standardized data management, reporting and analysis techniques for environmental applications, including GIS, expert systems, simulation and predictive modelling.

Standardization of national data-reporting and harmonized database management strategies are under development to facilitate cross-sectoral integrated assessments — for example, in the GEMS/AIR and GEMS/WATER programmes and regional programmes such as EMEP and EMAP. They complement ongoing efforts of UNEP's GRID to achieve a globally standardized method of handling spatial, referenced datasets.

Satellite systems

Proposition: The apparent increased attention to environmental information requirements in the design specifications of the new generation of earth resources satellites is most welcome.

Although the current generation of earth resources satellites, such as NASA's Landsat-x series, NOAA's NOAA-x series, and Telespatiale's SPOT, provide a splendid view of the earth's surface — in some cases, at resolutions down to nearly ten metres — many of them have been designed for applications other than those for which they are most popularly used by earth scientists. Thus, Landsat-x, originally configured for mineral exploration, and NOAA-x, for looking at clouds, are both being commonly used for vegetation change analysis. Thus, while the spectral bands are adequate, they are less than ideal for the applications. SPOT — the new series of sensors associated with NASA's EOS programme — the European Space Agency's ERS-1 and Japan's MOSS-1 all are designed to have a broader range of sensors that are useful for both terrestrial and marine environmental analyses. These should help expand the great potential of earth resources satellites, a potential that has largely been ignored in a world-wide development context over the last 20 years.

Proposition: Continued R&D investment will be necessary to help fill the global "ground truth" gap.

In many cases, the gap in correspondence of meaning between digital satellite data and features on the ground seems as wide as the distance between the space vehicle and the earth itself. Fortunately, the EOS programme is investing in ground-related studies as well as in spectacular hardware and software. New national space programmes around theworld show great technological

promise, and International Space Year could be an important catalyst for "ground truth" studies as well as an opportunity to sell national wares.

Telecommunications

Proposition: An urgent attempt is needed to consolidate and co-ordinate internationally the wildfire growth of telecommunications systems and protocols.

Despite available advanced technology, international telecommunications for environmental data exchange is somewhat of an electronic Tower of Babel. If this sounds extreme, the reader is invited to try to send a text data file from, say, UNEP headquarters in Nairobi via the local Kenyan packet-switching system, through Bitnet and the Telenet pad somewhere in North America, to the Forum Secretariat. As is the case with information systems, telecommunications systems, both public and private, will flourish willy-nilly. Efficient and speedy communication and exchange of data between information systems (see section entitled *Information systems*) will ultimately make use of existing electronic telecommunications networks.

Implementation Issues

Although Theme Paper Four in this series will look at institutional questions in depth, the following might be highlighted in the special context of monitoring and assessment.

Co-ordination

Proposition: Since information exchange is the first step to co-ordination between programmes, international co-ordinating efforts, such as the Forum, Earthwatch and the IBRD Programme on Environmental Information Systems in Sub-Saharan Africa should be encouraged.

Environmental problems span many disciplines and extend over vast areas. Therefore, no single programme can be expected to address them all fully. Every agency, whether national or international, has its own specific mandate; invariably, such mandates are sectoral, hampering communication and open exchange of information. Information exchange fora are beginning to be established in different regions, one example being the intersecretariat yearly meetings on air pollution in Europe, organized by the WHO Regional Office for Europe. In other sectors, and in the developing world, the situation is less clear. It is possible that a new approach to international co-ordination will arise out of the UNCED in 1992, even though the international community is resisting the establishment of new institutions. Over the past 30 years, public money has been spent in the development aid arena — through both bilateral and multilateral channels — to do the same things in the same countries. It is only now, with the Golden Age of the 1970s well behind us and attention being diverted from the South to the East, that donor bodies and UN Specialized Agencies are beginning to talk among themselves. The need for such dialogue, which, it is hoped, will lead to co-ordinated interventions, is obvious.

Technology transfer

Information alone does not guarantee action — the shelves of the developing world are stacked with unused information that has been collected by external bodies during development projects. The collection of the information is frequently duplicated in subsequent interventions. Why? Because, traditionally, what remained when the expatriate experts left was some new information but little new capability. It is absolutely essential that there be institutional capabilities at the national level to update, analyse, report on and use the information acquired.

Proposition: Increased support to national monitoring, assessment and data management capabilities in developing countries is essential, both to allow the countries to develop in a sustainable way and to provide the required global data coverage.

Developing countries participate in global monitoring networks only to a modest degree, or else have developed their own localized monitoring networks. In those developing countries where economic constraints prevent the operation of fixed-location monitoring stations for global assessment objectives, alternative monitoring systems — for example, the use of mobile regional monitoring teams and greater use of information derived from remote sensing — could provide at least interim solutions until realistic long-term funding is mobilized to support continuous operation.

Technology transfer to, and capacity-building in, developing countries — including training in the field of monitoring methodology and information handling, analysis, display and use — have been highlighted by UNEP's governing council as priority issues.

The proposed Global Environment Facility described in this paper is a framework structure which might reinforce global networks in developing countries, or, where none exist, facilitate their establishment.

Proposition: The international community should encourage the industrial sector to provide greater material support to the monitoring and assessment of the resource base that nurtures it.

The industrial sector has become increasingly aware of the need to pay attention to sustainable development. UNEP's Industry and the Environment Office has a full-time job directing the interests, energies and resources of industry towards investment in a sustainable resource base and a clean and habitable environment. IBM, through its support of GRID, is an example of a corporation that has made a material contribution to strengthening global, regional and national monitoring and assessment programmes.

Cost considerations

Monitoring programmes are often expensive, and the short-term benefits difficult to envisage, particularly in countries where food, shelter, security and other basic human needs are not being met as effectively as in the G-7 Summit states.

Most international and national bodies do not have sufficient resources to carry out basic monitoring and assessment effectively. If governments subscribing to the Forum are serious about wishing to co-ordinate and strengthen international monitoring and assessment, then money will have to be found to:

- strengthen the capacities of relevant UN agencies;
- support international co-ordination (e.g., within Earthwatch);
- meet the needs of developing countries in environmental monitoring, assessment, quality control and management of data; and
- extend observation coverage much more effectively to regions outside national jurisdictions (e.g., the world's oceans).

Proposition: Until the international community is prepared to cover the high costs involved, the FORUM debate is academic.

A recent report of the Secretary General to the UN General Assembly estimates the cost of achieving the above to be in the order of US$ 200 M per year. Most of these funds (around US$ 170 M) would be needed to assist developing countries in improving their national capabilities for monitoring, assessment and data management. The UN system would need around US$ 30 M for international monitoring and assessment programmes, with a relatively modest portion allocated to UNEP's co-ordination role within Earthwatch.

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Annex I - List of Acronyms

ACCIS	United Nations Agency Co-ordinating Committee Information System
AMCEN	African Ministerial Conference on the Environment
ARC/Info	Name of GIS software produced by the Environmental Systems Research Institute, Redlands, California
ARTEMIS	African Real Time Environment Monitoring Using Imaging Satellites
ASCII	American Standard Code for Information Interchange
AVHRR	Advanced Very High Resolution Radiometer, a satellite sensor
BAPMoN	Background Air Pollution Monitoring Network
CAP	Caribbean Action Plan
CFCs	Chlorofluorocarbons
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CORINE	Community-wide Co-ordination of Information on the Environment
DBMS	Data Base Management System
ECE	Economic Commission for Europe
EEC	European Economic Community
ELAS	Name of satellite image processing aid, a GIS software developed by NASA
EMAP	Environmental Monitoring and Assessment Programme (USA)
EMEP	European Monitoring and Evaluation Programme
EOS	Earth Observation System
EOSAT	Earth Observation Satellite Cooperation
EPA	Environmental Protection Agency
ERDAS	Earth Resource Digital Analysis System, a GIS software produced by ERDAS, Inc.
EROS	Earth Resources Observation System (EROS Data Center is a major USGS Center in Sioux Falls, South Dakota, USA)
ERS-1	Earth Resources Satellite (European Space Agency)
FAO	Food and Agriculture Organization of the United Nations
FORIS	FAO's Forest Information System
GA	General Assembly of the United Nations
GC	Governing Council of UNEP
GCM	Global Circulation Model
GDP	Gross Domestic Product
GEF	IBRD/UNDP/UNEP Global Environment Facility
GEMS	Global Environment Monitoring System
GGM	Greenhouse Gases Monitoring
GIEWS	Global Information and Early Warning System
GIS	Geographic Information System
GNP	Gross National Product
GRID	Global Resource Information Database
HEM	Harmonization of Environmental Measurements
IAEA	International Atomic Energy Agency
IBM	International Business Machine Corporation
IBRD	International Bank for Reconstruction and Development, the "World Bank"
ICPIC	International Cleaner Production Information Clearinghouse
ICSU	International Council of Scientific Unions
IDRISI	Name of GIS software produced by Clark University
IGBP	International Geosphere and Biosphere Programme
IMO	International Marine Organization
INFOTERRA	International Referral System on the Environment
IOC	Intergovernmental Oceanographic Commission
IPCC	Intergovernmental Panel on Climate Change
IPCS	International Programme on Chemical Safety
IRPTC	International Register for Potentially Toxic Chemicals

ISO	International Standardization Organization
IUCN	International Union for the Conservation of Nature and Natural Resources
LAS	Land Analysis System, a GIS software developed by NASA and USGS
MARC	Monitoring Assessment Research Centre
MOS	Marine Observation Satellite (Japan)
NASA	National Aeronautics and Space Administration
NGO	Non-governmental organization
NOAA	National Oceanic and Atmospheric Administration
OCA/PAC	Oceans and Coastal Areas Programme Activity Centre
OECD	Organization for Economic Co-operation and Development
QA	Quality Assurance
SCOPE	Scientific Committee on Problems of the Environment
SOE	State of the Environment
SPANS	Spatial Analysis System, a GIS software developed by Tydec Technologies Ltd.
SPREP	South Pacific Regional Environment Programme
SWMTEP	System-Wide Medium Term Environmental Programme
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO/MAB	United Nations Educational, Scientific and Cultural Organization — Man and the Biosphere programme
UNITAR	United Nations Institute for Training and Research
UNSO	United Nations Sudano-Sahelian Office; and United Nations Statistical Office
USGS	United States Geological Survey
WCMC	World Conservation Monitoring Centre
WCRP	World Climate Research Programme
WHO/EURO	World Health Organization/Regional Office for Europe
WMO	World Meteorological Organization
WRI	World Resources Institute
WWF	World Wildlife Fund (USA)
WWW	World Weather Watch

Annex II - Publications Describing Major Monitoring Programmes

Barnes, R.F.W. *The status of elephants in the forests of Central Africa: results of a reconnaissance survey.* Typescript report on behalf of the WCI team, Wildlife Conservation International (1989).

Carter, G.C., ed. "Directions for Internationally Compatible Environmental Data," *CODATA Bulletin* (Volume II). ISBN 0-89116-128-7, ISSN 0366-757x (1989).

Clarke, R., ed. *Handbook of Ecological Monitoring.* ISBN 0-19-854590-8. Oxford Science Publications (1986).

Diamondstone, B.I., ed. "Directions for Internationally Compatible Environmental Data," *CODATA Bulletin* (Volume I). ISBN 0-89116-792-7, ISSN 0366-757x (1988).

Douglas-Hamilton, I. *Overview of Status of Trends of the African Elephant.* EEC/WWF African Elephant Programme, Report to Ivory Track Review Group (1989).

ECE/UNEP. *Forest Damage and Air Pollution.* Report of the Forest Damage Survey in Europe, Geneva (1986-1988).

FAO/UN. *Animal Health Year Book.* ISBN 92-5-002960-8. FAO, Rome (1989).

_____. *Fishery Statistics* (Volume 66). ISBN 92-5-002937-3. FAO, Rome (1988).

_____. *Forestry Year Book of Forest Products.* ISBN 92-5-002892-x. FAO, Rome (1988).

_____. *The State of Food and Agriculture.* ISBN 92-5-102838-9. FAO, Rome (1989).

FAO/UNESCO/IOC/WHO/WMO/IAEA/UNEP. "Co-ordinated Mediterranean Pollution Monitoring and Research Programme (MED POL) — Phase I: Programme Description," *UNEP Regional Seas Reports and Studies*, No. 23 (1983).

Gwynne, M.D. "The Global Environment Monitoring System (GEMS)," *Environmental Conservation*, 9 (1): 34-41 (1982).

Houghton, J.T., Jenkins G.J. and Ephraums, J.J., eds. *Climate Change: The IPCC Scientific Assessment Report*, prepared for IPCC. Working Group I, WMO/UNEP. ISBN 0-521-40720-6 (1990).

INFOTERRA. "A directory of information on air and water pollution." ISBN 92-807-1233-0. Narobi, Kenya (1989).

IRPTC. Legal File. ISBN 92-807-1163-6. United Nations, Geneva (1986).

IPCS. *Environmental Health Criteria 105, Selected Mycotoxins: Ochratoxins, Trichothecenes, Ergot.* ISBN 92-4-157105-5 (1990).

W.J. McG. Tegart, G.W. Sheldon and D.C. Griffiths, eds. *Climate Change: The IPCC Impacts Assessment Report*, prepared for IPCC. Working Group II, WMO/UNEP. ISBN 0-644-13497-6 (1990).

Michelmore, F., Beardsley, K., Barnes, R. and Douglas-Hamilton, I. *Elephant Population Estimates for the Central African Forests.* Report to the Ivory Trade Review Group. EEC/WWF African Elephant Programe Wildlife Conservation International (1989).

NADP/NTN. National Atmospheric Deposition Program, annual data summary. *Precipitation Chemistry in the United States.* Natural Resource Laboratory, Colorado State University, Fort Collins, Colorado (1988).

NASA/FAA/NOAA/UNEP/WMO/CEC/BMFT. *Atmospheric Ozone 1985.* Assessment of our understanding of the process controlling its present distribution and change. Prepared by scientists from the National Aeronautics and Space Administration, Federal Aviation Administration, National Oceanic and Atmospheric Administration, United Nations Environment Programme, World Meteorological Organization, Commission of European Communities, Bundesministerium für Forschung und Technologie. Global Ozone Research and Monitoring Project Report No. 16 (three volumes). World Meteorological Organization, Geneva (1986).

OECD. *Environmental Data Compendium.* ISBN 92-64-03223-1, Paris (1989).

Pearce, D. and Freeman, S. "Information requirements of policy decision-makers." Theme Paper One, International Forum on Environmental Information, Canada (1991).

Schang, J., Skjelmoen, J.E., Walker, S.E., Pederson, U. and Harstad, A. EMEP: Co-operative Programme for Monitoring and Evaluation of the Long Range Transmission of Air Pollutants in Europe. *Data Report 1987* (Part I: Annual Summaries; Part 2: Monthly and Seasonal Summaries). Lillestrom: Norwegian Institute for Air Research (1989).

UN. *Report of the United Nations Conference on the Human Environment*. Stockholm, June 5-16, 1972. Ref. A/CONF. 48/14/Rev.1, p. 77. United Nations, New York (1973).

UNEP. "Action plan for the protection and development of the marine environment and coastal areas of the West and Central African Region." *UNEP Regional Seas Reports and Studies*, No. 27. UNEP, Nairobi, Kenya (1983).

_____. *Earthwatch, An In-Depth Review*. Report No. 1. Na. 81-4211-Feb. (1981).

_____. *Environmental Data Report* (2nd edition), ISBN 0-631-16987-3. Basil Blackwell Ltd. (1989-90).

_____. Global Environment Monitoring System. UNEP, Nairobi, Kenya (1990), (brochure).

_____. Global Resource Information Database. Nairobi, Kenya (1990), (brochure).

_____. *Montreal Protocol on Substances that Deplete the Ozone Layer: Final Act*. UNEP, Nairobi, Kenya (1987).

_____. *Oceans and Coastal Areas, Catalogue of Publications, No. 5*. UNEP, Nairobi, Kenya (1989).

_____. *Regional Seas, Reference Methods and Materials*. UNEP, Nairobi, Kenya (1990).

_____. *Register of International Treaties and Other Agreements in the Field of the Environment*. UNEP/GC.15/Inf. 2. Nairobi, Kenya (1989).

UNEP/HEMO. *A Survey of Environmental Monitoring and Information Management Programmes of International Organizations* (draft), (1990).

UNEP/WHO/UNESCO/WMO. *GEMS/WATER Operational Guide*. World Health Organization, Geneva (1987).

United Nations Fund for Population Activities. *Demographic Year Book*. ISBN 0-88086-017-0 (1986).

UNGA. A/CONF.151/PC/6, "Overview of System-wide activities relevant to General Assembly Resolution 44/228," note by the Secretariat (1990).

UNSO. *Energy Statistical Year Book*. ISBN 92-1-061135-7. UNSO, New York (1988).

WMO/UNEP. "Scientific Assessment of Climate Change: The Policymakers' Summary of the Report of Working Group I for IPCC," (1990).

_____. "Impacts Assessment of Climate Change: The Policymakers' Summary of the Report of Working Group II for IPCC," ISBN 0-644-13496-8 (1990).

_____. "Support to the Intergovernmental Panel on Climate Change: The Policymakers' Summary of the Formulation of Response Strategies." Report prepared for IPCC. Working Group III, WMO/UNEP (1990).

World Bank. *World Development Report*. ISBN 0-19-520850-1. Oxford University Press (1990).

WCMC/IUCN. *Red List of Threatened Animals*. ISBN-2-88032 935-3 (1988).

WRI (in collaboration with UNEP/UNDP). *World Resources*. ISBN 0-19-506229-9 (1990-91).

Theme Paper Three

Reporting Environmental Information

by

Susan Holtz
Environmental Policy Consultant

Nova Scotia, Canada

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Introduction

This paper was prepared as one of four theme papers for the International Forum on Environmental Information for the Twenty-First Century. Its focus will be a synoptic overview of the vehicles and analytic approaches that are currently in use for reporting environmental information, and a summary review of outstanding issues for the future. The perspective is primarily that of public policy decision-making, although some attention is given to corporate-sector decisions as well.

It should be kept in mind that the four themes for discussion at the Forum — information needs, monitoring and technology, reporting environmental information, and institutional arrangements — are all closely interconnected, and that it is not possible to discuss any of them without some overlap with the others.

The general conclusion of this paper is that, at the present time, environmental reporting is moving from a 1970s focus on discrete issues to a more comprehensive approach which reflects an understanding that all human activities have environmental consequences. State of environment reporting, national and sectoral environmental plans, environmental indicators and national accounts are in emerging or "adolescent" stages of development for use in actual policy formulation and policy assessment, and in making specific decisions about regulation, international agreements and the like. It is a formidable challenge to present information about complex human-environment relationships in ways that are responsive to decision-makers' needs for brevity, accuracy and credibility. Finding ways to demonstrate and present the links between a comprehensive analysis of environmental effects and an actual or possible course of action is the overall need that must be more effectively addressed.

Reporting Environmental Information: An Overview

The Historical Context

The context for environmental reporting was shaped by the growing awareness in the industrialized world in the 1960s and 1970s of the previously overlooked side-effects and by-products of 20th century technologies and products like synthetic pesticides. Rachel Carson's 1962 book, *Silent Spring*, which detailed the devastating effects on bird populations of the use of persistent pesticides like DDT, was a milestone in the development of this new consciousness.

The first United Nations conference on the human environment, held in Stockholm in 1972, brought other perspectives to the issue. Fearing that the pollution concerns of the wealthy nations would result in restrictions on economic growth in poorer countries, the developing nations insisted that their concerns also be addressed. The need for comprehensive and scientifically credible information at the regional and global levels thus began to assume considerable importance for the resolution of this tension-filled dialogue.

Similarly, political and social concerns about the resources required to support an exploding global human population began to be debated in the 1960s, particularly with respect to the resource requirements of wealthy nations. This debate spawned early environmental modelling exercises, such as those done in the 1970s by the Club of Rome. The Organization of Petroleum Exporting Countries (OPEC) oil embargo of 1973 also added impetus to the increasing demand, especially from policy-makers, for information about national and global resource use and its environmental implications.

The Present Context

By now, nearly two decades after the first United Nations conference on the environment, the context has again changed. Although many specific issues between North and South remain unresolved, the ideological debate about environment and development is largely over. Virtually all countries recognize that ecological problems are both real and serious, and that ecological, economic and social problems and their solutions are linked, rather than separate.

Several events have marked the progress of this discussion, two of the most important being the development of the 1980 World Conservation Strategy and the 1987 Report of the World Commission on Environment and Development (the Brundtland Report). The World Conservation Strategy marked a conceptual turning point, in that it clearly identified the basic ecological constraints which economic development in all countries had to respect. Its three goals are: maintenance of essential ecological processes and life-support systems, sustainable use of species and ecosystems, and preservation of genetic diversity. These basic objectives are so clearly essential to the well-being of human societies that, apart from some further refinements in the thinking about genetic/biological diversity, there has been little subsequent debate about them. The constraints implied by these goals provided the first environmental

check-list against which development could be universally assessed, at least in principle.

The Brundtland Report included an extensive discussion of both environmental and human problems, and went beyond the World Conservation Strategy in its endorsement of *sustainable development*. What was ground-breaking was the recognition that economic, environmental and social goals are *all* critical in a sustainable society. The report's emphasis on creative policy integration, and on policy directions that simultaneously meet economic, social and environmental objectives, differed from the earlier idea of a "balance," in which basic goals are not acknowledged, but instead must compete and may be fundamentally compromised.

Thus, the context for reporting environmental information has changed in the last two decades in that there now *is* a context — namely sustainable development — that provides a larger framework for environmental policy and goals.

Core Questions About Environmental Reporting

The basic question which encapsulates the issues in reporting environmental information is "*Who* is reporting *what* to *whom* and *why*?"

The changing purposes of environmental reporting

The larger context, whose evolution we have just reviewed, addresses *why*. Threats to human and ecosystem health and well-being, to the resource base and to spiritual and aesthetic values, continue. The public holds decision-makers in both the public and corporate sectors responsible for these problems, and wants and expects remedial action. Both the public and the decision-makers need to be able to assess the effectiveness of any action; in order to do this, they must have information on environmental trends and conditions. Information is needed to determine future action, to evaluate cost-effectiveness and to promote political (and sometimes legal) accountability.

However, social and economic issues are also matters for public policy, and decision-makers are held accountable for unemployment, health care policy and similar matters, as well as for environmental quality. The policy context of sustainable development recognizes that these issues are intertwined. For example, sectoral energy policy may in the past have encouraged energy megaprojects — such as offshore petroleum development or hydroelectric dams — that had negative environmental impacts, but provided employment and tax revenues. Now, public policy-makers must continue to address the socio-economic dimensions of policy along with new environmental quality goals. Determining how to do this so that environmental, social and economic information can be appropriately compared or integrated is one of the main challenges of environmental reporting.

The flow of information in environment-related decisions

New information about the environment, particularly about environmental processes and anthropogenic effects, is the stimulus for all environment-related decisions. But those who generate environmental information are not the same as those who eventually use it to make public policy and corporate decisions. In fact, for each stage in the flow of environmental information, from research data to policy decisions, there are different information users who need different kinds of information in order to fulfill their particular responsibilities. This means that there has often been a mismatch — in the focus, format or content — between the information needed and the information available.

The following table (Table 1) describes the flow of information in the process of making environment-related public policies and decisions. For each step in the process, the main actors and the action to be taken are identified.

Table 1 is a general schema applying to national and subnational policy decisions. It also applies to the development of international agreements and treaties. In such cases, however, there are additional decision loops, in which a general agreement to act is followed by negotiations involving officials and policy analysts to work out precise details. This is similar to consultation processes on legislative and regulatory details at the national level.

Environmental reporting for policy decision-making

For each of the steps in Table 1, there are different vehicles for reporting relevant information. For example, scientific research that identifies or analyses biophysical conditions must typically be published in peer-reviewed scientific journals in order to have credibility. Only after it has received that stamp of legitimacy does it become part of the information flow in the decision-making process that ultimately determines public policy. From there, information is picked up and reported in activist

ENGO newsletters, industry journals and the press, usually as a call for action. When public pressure becomes strong, corporate and political decision-makers take action. Anticipating this, analysts from different sectors will collect scientific, technical and economic information to begin formulating their own preferred alternatives for action. At this point, the accuracy, reliability and relevance of the information available become critical to the success of different proposals.

Table 1
Information Flow in Policy Decisions

Step 1: Problem is identified. Actors: Scientists, and sometimes resource users (e.g., hunters or foresters) or observers (e.g., bird-watchers). Action: Information is generated and analysed through observation, research-oriented data collection and scientific analysis.
Step 2: Action on the problem is demanded/considered. Actors: Environmental non-government organizations (ENGOs); the media, and through them, the concerned public; industries and individuals directly affected by the problem. Action: Information is used to draw attention to the seriousness of the problem, in order to motivate action for remediation.
Step 3: Alternatives for action are formulated. Actors: Policy analysts from different disciplines (e.g., law, economics, environmental sciences, engineering) working for ENGOs, industry, government, universities and research institutes. Action: Information is used to determine precise human responsibilities for the problem, costs and consequences of the problem, and costs and consequences of alternative courses of action.
Step 4: Courses of action are decided. Actors: Politicians and their senior advisers and (in the private sector, when action is taken voluntarily or legally mandated) CEOs, Boards of Directors, senior managers. Action: Information is used to evaluate the impacts of different courses of action on the different constituencies to whom the decision-maker is responsible.
Step 5: Feedback on action is required. Actors: Scientists, resource users and observers monitoring environmental effects; statisticians, economists, corporate managers and others monitoring economic and social effects. Action: Information is generated to monitor the economic, social and environmental conditions and changes that occur in response to the chosen course of action.

However, the decision-makers are not themselves in a position to assess the underlying information and analysis. They must proceed on the basis of the apparent coherence of the proposal, which depends upon the transparency of the links between human management and biophysical improvement. As well, policy decision-makers must weigh the intended biophysical results against the impacts of the decision on the various constituencies to whom they must respond. If some of those impacts are negative, the decision-maker must rely on the strength of the argument to justify and sell the decision. For this task, pithy, emblematic and coherent information in a highly accessible format is needed.

Finally, follow-up is needed. Is the action taken having the desired effect on the environment? If not, was the science inaccurate? the technology unsuccessful? the scope of the problem underestimated? Are management violations being inadvertently or deliberately allowed? And are the socio-economic effects acceptable? too costly? Is there a more elegant, cheaper or more effective way to approach the whole issue? Finally, the circle of information flow must be closed with ongoing environmental monitoring and analysis.

Environmental reporting today

It is only now, after two decades of growing environmental concern and political and corporate action, that we are beginning to develop reporting vehicles appropriate to the third, fourth and fifth steps in the decision-making process. Throughout the 1970s and into the 1980s, environmental concerns were struggling to gain legitimacy on the political agenda. Most environmental reporting took place in a context of delineating environmental problems and calling for action. As a result, much past reporting, even that intended for decision-making, has been focused on the biophysical dimensions of the issues, rather than on clarifying the links to human activities. However, it is the latter that is vital to decision-makers, as shown in Step 3, in Table 1. Knowledge of deteriorating biophysical conditions triggers action, but policy decisions are about restricting and managing human activities.

Two important shifts that profoundly affect the environmental information needed for policy decisions are currently taking place. First, the resolution of the environment-versus-economy debate through the acceptance of sustainable development as an overarching concept has shifted the goal away from developing environmental policy as an add-on, to "fix" problems. Sustainable development recognizes that a healthy economy also requires healthy ecosystems, a healthy resource base and a healthy human population, as well as sectoral policies and corporate planning decisions that build in environmental goals. To achieve this, all policy and decision-making processes must explicitly identify environmental constraints and goals, along with their more traditional socio-economic constraints and goals. As discussed earlier, the goals of the World Conservation Strategy provide a broad (although not locally explicit) framework for such decision-making. Reporting vehicles that bring this information together for different economic sectors are therefore needed.

Second, the understanding of the nature of the problem has changed. The development of the World Conservation Strategy and related attempts to grasp and interrelate environment-economy issues have led to the clear understanding among policy analysts and, increasingly, among all levels of society, that the essence of the problem is not how to regulate a few "bad" industries. Rather, we now recognize chemical, physical and biological change as a constant; since all human activities create environmental change, we need a much more comprehensive understanding of the conditions, trends and processes in the natural environment. In the absence of a comprehensive understanding, trying to improve one problem may well create a worse one. Comprehensive reports on the state of the environment are therefore increasingly important as part of the information background for policy-makers.

In the next section of this paper, the focus will be on reporting vehicles that are particularly relevant to decision-making in today's context.

Vehicles for Reporting Environmental Information: A Review

The preceding section discussed some of the issues related to environmental information reporting that arise in the context of making corporate and public policy. The implicit question is whether decision-makers are, in fact, getting information about the environment that is relevant to their needs. This section of the paper will review the existing and developing vehicles for reporting the environmental information needed for policy-making.

Whose Needs Shape Environmental Reporting?

A point to consider in the following review is the roles

played by different actors in the information flow leading to policy decisions. For example, to what degree do the perceived information needs of those not actually involved in the decision-making process — for example, journalists and the general public — shape the content and format of the reporting vehicles most relevant to policy decisions? Is there sufficient clarity about the information needs that different reporting vehicles currently address?

In Table 1, the last three steps — analysis of alternatives, the decision, and monitoring for feedback — are of primary concern in decision-making, and are thus the main focus of this paper. The first two steps that are necessary — identifying an issue and getting it on the public agenda for action — require different formats and different types of information. Even in the three steps involved in the decision and follow-up processes, the information needs of the various actors differ. As a rule, the data and information sought by policy analysts, politicians and their political advisers, and scientists and statisticians involved in monitoring, will be reported in different formats and will also vary in terms of content.

From Issues to Overviews

As discussed in the first section of this paper, the reporting of environmental information has traditionally focused on "issues." However, there have been significant changes in this orientation.

Towards the end of the 1970s, it was becoming clearer to people and institutions engaged in environmental issues that they needed a better understanding of what was happening in, and to, the environment as a whole. What was happening to ecosystems on a regional, or even a global, scale? What were the cumulative impacts of many different environmental stresses, or of a given contaminant emanating from many different sources?

So what had been accomplished after about a decade of new environmental initiatives in the form of institutions, legislation and international agreements? How could overall progress or failure be measured? Was the general health of the environment — whether local, national or global — getting better or worse? Was it possible to identify thresholds of environmental significance? Was it possible to sort out natural environmental fluctuations from anthropogenic change? Were we really addressing the right issues, and assigning the right priorities in our attempts to manage human activities causing environmental change?

To provide answers to these kinds of questions, work began on the development of reporting vehicles that took an overview approach, rather than focusing on discrete issues. Such reporting requires, primarily, a conceptual framework that is capable of describing overall environmental change and of linking that change with both anthropogenic and natural causes. As they emerge, environmental issues and problems must be able to be placed within such a framework; the links with other issues must be logically clear. Ultimately, environmental reporting must be useful as a critical management tool for assessing progress towards ecological sustainability. For the reporting to be a useful tool, it is of the utmost importance that the conceptual model or framework be appropriate. Only with a good framework can the larger directions for structural change emerge clearly among the many pressing issues.

Content Focus in Environmental Reporting

The developing need for an overview approach does not, of course, diminish the continuing usefulness of issue-oriented, in-depth environmental reporting. The two approaches to environmental information are complementary, rather than opposing. In the area of environmental reporting for policy decision-making, however, the divergence between them is the most difficult problem to resolve within a particular reporting vehicle. Politicians have need issue-oriented information in order to maintain personal credibility in responding to public concerns. However, coherent and effective public policy cannot be developed without comprehensive information based on a sound framework. Unfortunately, each of these two exercises requires a very different structuring of information. Hybrid approaches have often been used in the reporting vehicles described in the following section, but such solutions usually lack a strong, clear focus.

Other aspects of environmental reporting about which there are a range of choices include the time frame (from a snapshot of a particular moment to long-term trends) and the spatial scope and organization (how large an area is covered, and how the boundaries are drawn — that is, whether they delineate political jurisdictions or ecological features). As well, there is the continuum, ranging from data to information — that is, from the publication of a measurement to the interpretation, in technical terms, of its human and ecological significance.

Finally, a word about the statistics upon which environmental reporting is based. All reporting systems, however excellent their conceptual framework, still depend on good data. However, very few data are specifically developed in order to contribute to policy formulation or an overall assessment of environmental quality. Most

data come from activities such as compliance monitoring, research studies conceived for another purpose, and the like. Consequently, there exists a real danger that the sheer availability of some data — and, conversely, the lack of other, needed data — will distort the information base on which policy decisions rest.

The Presentation of Information

Another set of general issues in reporting environmental information revolves around presentation. While clarity, precision, transparency and visual impact are always important, user needs will vary. In addition to making use of electronic databases and other electronic modes of storing and accessing information (for example, electronic mail), policy analysts and researchers continue to use traditional forms of narrative analysis and tabular data.

However, for actually making policy decisions, presenting them to the public and making information available for political accountability, the information has to be highly condensed. Maps, trend lines and pie charts, as well as other forms of graphic display that give the big picture, are necessary. The tension here is between transparency and precision on the one hand — which allow outside policy analysts to review the basis for the decision — and, on the other, the need to simplify in order to present the overall thrust very clearly. In part, this is a technical problem for graphic designers to solve. However, the balance has often been tipped towards over-simplification, and, when the information is about issues on which action is contemplated (such as national contributions to greenhouse gas emissions), ways must be found to avoid distortion.

Vehicles for Environmental Reporting

State of environment (SOE) reporting

Description

SOE reports provide an overview of environmental conditions, trends, processes — and sometimes issues — in a region, including information on natural economic resources. Some SOE reports also include management responses, such as legislative initiatives.

Publishing/sponsoring agencies

SOE reports are produced by: national environmental agencies, often in collaboration with national statistical agencies, and, in developing countries, often with the assistance of development aid organizations; international agencies, notably the Organization for Economic Co-operation and Development (OECD) and the United Nations Environment Programme (UNEP) — the latter for regional reports, such as those prepared for the Regional Seas Programme; and private organizations, such as the Worldwatch Institute (US), the Conservation Foundation (US), and Friends of the Earth (Malaysia).

Relevance to decision-makers

The main users are analysts from many sectors who assess the results of past action and the future policy directions that are needed, particularly in the sustainable development context of integrating social, economic and environmental goals. Journalists and the general public use synoptic versions for personal education about the environment, and in seeking accountability for resource sustainability and environmental management policies from political leaders and corporations.

Discussion

SOE reports moved environmental reporting into a consciously comprehensive framework. Following pioneering national reports by Japan and the United States in the 1970s, the ministers of the Environment from the OECD countries approved a recommendation in 1979 that the OECD itself, as well as its member countries, should publish regular SOE reports. These reports were intended to supplement the regular reporting done by the countries concerned on economic and other aspects of national life (Averous, 1989). According to a recent World Resources report (World Resources 1991), by 1989, more than 40 countries had prepared at least one SOE report; a smaller number also had a compendium of environmental statistics. United Nations agencies such as UNEP, the Food and Agriculture Organization (FAO) and others, as well as a number of private agencies (particularly ENGOs), also publish comprehensive SOE reports. The process of preparing for the 1992 United Nations Conference on Environment and Development (UNCED) in Brazil has set in motion the preparation of SOE reports from all countries.

This level of activity does not mean international (or even national) agreement about the framework for SOE reporting. UNEP's reporting on the state of the world is instructive. The Governing Council of UNEP decided in the mid-1980s that its annual state of the world environment reports should alternate in successive years between a focus on socio-economic relationships to environmental quality and a biophysical assessment. However, for the 1989 report, the Governing Council asked for an update on the 1987 state of the world environment, with an in-depth issues focus.

Consequently, the *State of the World Environment 1989* had general information on environmental conditions, but major sections on climate change and toxic waste. The private Worldwatch Institute's series of State of the World reports, published annually since 1984, still uses an issues approach, which includes both a problem analysis for each topic and a discussion of management responses. However, its reporting on each topic is truly global in scope. The sheer scale on which information is presented constitutes, by itself, a comprehensive framework.

Some national reports, such as those of the United States, also use issues as either the basis of their framework or as a supplementary dimension of it. Others are organized around the biophysical components of the environment: land, water, air and wildlife. Some use a systems framework that focuses on the generic causes of environmental change as well as on the state of environmental components. All of these frameworks are capable of charting changes in the environment. However, only the systems framework has the capacity to also begin relating the causes of change to the change itself. Moreover, only a framework which can categorize *all* the different kinds of stresses on the environment is useful in developing environmental policies that are concerned with sectoral trade-offs and overall constraints on human activities. The concept of sustainable development, as well as the need to act on such large-scale problems as global warming, are making such conceptual frameworks for environmental reporting more and more valuable.

Consistency from one report to the next presents problems as well. If the framework evolves as understanding increases and user needs become better defined, comparability is lost. If comparability is maintained, opportunities for a more transparent presentation of relationships are sacrificed. The OECD State of Environment reports, published every six years since 1979, have used a consistent but somewhat simple framework of stresses, or "pressures," on environmental components from such sectors as agriculture, industry, transport, energy and other sources; the OECD reports also document management responses affecting environmental components. Also since 1979, Environment Canada has published an SOE report on Canada's Atlantic region every six years. In contrast to the OECD report, its conceptual framework has changed each time, evolving towards an elegant and easy-to-grasp stress-response framework in 1991. Stresses from all sources are now grouped into the broad generic categories of pollution, resource utilization, significant physical alterations, and natural events. However, while the conceptual framework has been strengthened, it is very difficult to compare the 1991 information with that in the two earlier reports.

Few, if any, SOE reporting programmes have truly come to grips with the interpretation of environmental information in terms of values. Environmental change is a fact of life (and of pre-life, of geological history). However, at the public and political levels, there is an expectation that SOE reporting should make evaluations about the quality or health of the environment. Indeed, there is often strong public, political and media pressure on these programmes to provide a "report card." But how (given the fact of continuous change) can current change be logically characterized? Clearly, the frame of reference must be anthropocentric. Even so, there are obvious value differences among people about what constitutes a high-quality environment. While some attempts to base this value judgement on ecological theory (for instance, Friend and Rapport, 1990) may be promising, they are not universally accepted. Until there are actual national and international environmental quality objectives, SOE reporting will be essentially subjective in its value judgements, or even evasive. (It should be noted that as the number of international environmental accords and treaties increases, so too does the number of objective (if sometimes arbitrary) standards available.)

There are also thorny issues concerning the time frame and the spatial scope of an SOE report. Everyone, from scientist to citizen to politician, wants to see trends and context. Unfortunately, reliable data have been collected for such a short time that this is often impossible. On the question of spatial boundaries, the tension is between the approach needed for management accountability (which is based on political jurisdictions) and that needed for ecological analysis (which is based on natural boundaries like ecozones and watersheds). Neither approach is complete by itself.

In the last few years, there has been greater recognition among governments and policy researchers of the need for SOE reporting to be an ongoing activity, and not just a "one-time" event. With this realization, more attention has been paid to developing a range of SOE "products," apart from the typical thick, book-sized, printed report. A number of audiences have been identified for different products. For their part, decision-makers are concerned about improving public accountability by giving the various publics — citizens, ENGOs, journalists, educators and policy researchers — better information for assessing the state of the environment, and, indirectly, the performance of public decision-makers. Canada provides an example of the shift from "one-time" to ongoing reporting; state of environment reporting there is now a

programme, currently undertaken jointly by Environment Canada and Statistics Canada, with products ranging from the five-year "big" reports on the state of the environment and a statistical compendium to regular fact sheets, technical reports, a newsletter on state of environment reporting, and co-publishing of books with commercial publishers (including a comprehensive, full-colour book on endangered species in Canada, identifying the endangered species found in each of the country's seven large ecological zones).

Electronic databases will increasingly be available, as will *interactive electronic information systems*. The use of Geographical Information Systems (GIS) in developing SOE reports, particularly the increasing use of maps to display environmental stresses and conditions, will become more important as SOE reporting becomes an activity and not just a publication. Also promising are *future scenarios*, which are useful in environmental assessment research, as part of a national or international action plan, as well as in the context of SOE reporting.

National accounts

Description

Three separate types of initiatives are included in this category. First, there is natural resource accounting, which presents information on such things as ecological health, stocks, withdrawals, additions, and significant trends in the physical condition of natural resources (e.g., fisheries and forests), as well as related economic information. Secondly, there are satellite national accounts, which attempt to adjust the information presented in national income accounts by deducting environmental expenditures. Such adjustments, which are shown in a separate satellite account, do not affect the existing system of national accounts (SNA). The third and most radical approach is to develop mechanisms for actually adjusting the SNA to reflect the depreciation of natural environmental assets.

Publishing/sponsoring agencies

The work in the field of national accounts is being led by the United Nations Statistical Office (UNSO), the World Bank and the OECD. As well, statistical and resource agencies in different countries are working on their own approaches — for example, Norway's work on natural resource accounts, France's ambitious program to develop all three approaches into patrimony accounts, and work in Australia, Canada, Japan, the Netherlands, the United States and Germany. Also, Robert Repetto of the World Resources Institute (WRI) has developed an approach that has been applied in Indonesia.

Relevance to decision-makers

Although there have been some practical applications of this work, such as in energy and resource policy in Norway, the field is now in the early stage of development, and it is difficult to assess its practical importance for decision-making. The more modest approaches — natural resource accounting and satellite accounts — can provide decision-makers in resource sectors with more focused and comprehensive information about resource sustainability. Satellite accounts can provide additional information to Finance ministers about the costs and benefits of environmental protection. Changes to the SNA — the approach that is furthest from being widely implemented — can give a more accurate picture of the real economic state of a country, by incorporating the environmental contribution to national wealth or income in the regular national accounts. However, there are conceptual difficulties with most of the approaches suggested, and how and whether these can be overcome is uncertain; at least, it is uncertain whether the solutions worked out for implementing these approaches would add any significant value to existing biophysical information.

Discussion

In the last few years, many commentators have noted that conventional economics ignores the ecological status of the natural resource base that provides the inputs of renewable and non-renewable materials to a national economy. Moreover, they have pointed out, national economic accounts do not reflect the health of natural ecosystems that provide "free" waste disposal and life support for human activities. Many feel that if these environmental factors could be incorporated into national accounting systems, decision-makers in both the public and the private sectors would have a source of integrated environmental and economic information that more accurately reflects reality. Such information, some argue, is essential for decision-making that incorporates ecological considerations.

The ongoing international effort — spearheaded by the United Nations and the World Bank — has now been joined by agencies in a number of countries. UNSO has published a draft SNA booklet on integrated environmental and economic accounting, and work on satellite accounts is continuing in the OECD countries. A review of the complexities of both the statistical

frameworks and the concepts behind the accounting mechanisms is beyond the scope of this paper (although frequent, and lengthy, technical papers on these issues are available). It is important to remember that hammering out the details of how to set up our current systems of national accounts was a 40-year process!

However essential this effort to move national accounting practices closer to the physical reality may be, the relevance of its success to public policy decision-makers remains unclear. The central question is whether the translation of physical data — say, the status of a renewable resource stock, such as trees or fish — into some economic value will serve the information needs of policy decision-makers in any significant way. In the case of income accounts, for example, the criticism has been made that deducting environmental expenditures because they are a "defensive" expenditure applies equally to any number of other expenditures (e.g., health care); thus, there is no underlying logic in classifying this as a special expenditure. Similarly, it is difficult to set up natural resource accounts in the area of international trade; to what degree does sustainable use require self-reliance?

There is a "plus" side to these initiatives, however. Clearly, if rapid growth in national income is achieved at the cost of running down environmental quality and natural assets, real income over the longer term will be lower — possibly much lower — so corrections aimed at reflecting this, particularly in developing countries, are a worthwhile effort. At this point, most of the difficulties are conceptual and technical. Probably the best way of advancing the cause is simply to encourage many countries to get involved, and to develop practical experience in dealing with the difficulties (Hamilton, 1991). Fortunately, it appears that lack of an international consensus on new mechanisms need not affect the development of the statistical base. The kinds of statistics required are much the same no matter which approach is used, and countries need not wait for clarification of all the issues before setting up their own statistical sections to support this work (Peskin and Lutz, 1990).

Environmental Indicators and Indices

Description

Environmental indicators can either be a particularly representative measure, or a particularly sensitive measure, depending on whether they are designed to give early warning of a change in conditions, or to give an accurate representation of the current state of the environment. They can indicate environmental conditions or trends, environmental stresses, management responses, as well as the way in which all of these are linked with economic measures. Simple indicators are a direct measurement of a condition or stress; composite indicators show a ratio, such as the number of species per hectare or the volume of SO_2 emissions per tonne of fossil fuel burned. Some biological indicators are considered composite indicators of a variety of stresses that are often health-related. Indices are averages of a variety of indicators, weighted numerically; they provide a one-number summary of a range of factors.

Publishing/sponsoring agencies

Considerable preliminary work was done by the US Environmental Protection Agency (EPA) in the 1970s, but this effectively stopped in the 1980s. In 1989, EPA Region X published a set of indicators and indices it had developed. Now, a handful of countries and agencies are engaged in developing environmental or sustainable development indicators. In 1989 and 1990, the OECD was asked by the G-7 Economic Summit to initiate and continue development of environmental indicators. It published a preliminary set of indicators in 1991, as did Canada. The World Resources Institute (WRI), the World Bank and a number of private agencies are also involved in this work. However, unlike national accounts, indicators tend to be tied to specific concerns, so there is less reason to standardize them internationally.

Relevance to decision-makers

As succinct and easily communicated information, indicators have great utility in assisting decision-makers' own assessments and understanding of environmental conditions, and of their links with sectoral and economic policies. They are extremely useful for promotingaccountability for the assessment of national performance. Because of concerns about distortion or over-simplification, policy analysts outside the agency responsible for developing them tend to treat any set of indicators with extreme caution.

Discussion

When they were eventually produced, comprehensive, periodic SOE reports were too big to be useful to politicians, citizens and journalists in undigested form. It was precisely the quality which they were designed to have — comprehensiveness — that, at worst, made them unreadable, and, at best, a reference guide. Moreover, they took a long time to produce — what was happening three

years later? What many groups felt they needed was the *essence* of an SOE report: a set of environmental indicators that could track ongoing developments.

In the 1970s, many politicians felt that the most succinct of all would be an environmental quality index, that is, a set of indicators numerically weighted and averaged together to give a one-number reading. Researchers reviewing this idea have generally come to the conclusion that the difficulty of weighting the different dimensions of environmental quality precludes the development of a meaningful index (Sheehy, 1989). Indices are used for assessing air and water quality in Canada, the US and elsewhere, but the underlying data and weighting continue to be criticized for lack of validity and scientific rigour (Sheehy, 1989). A 1990 study by the WRI on environmental indicator research is pessimistic about the conceptual difficulties involved in developing indices, and concludes that, along with the lack of usable global data sets, such problems account for the relative lack of policy-relevant research (World Resources Institute, 1990).

The same data difficulties as those seen in SOE reporting beset indicator development; if anything, they are worse because of the fact that only a few key measures are available. Nevertheless, the OECD and some of its member countries have made considerable progress in this field over the last two years, partly because there has been a high level of interest. During the past year in Canada, agencies as diverse as the National Round Table on Environment and Economy, Southam News Service and Environment Canada have all commissioned significant research on indicators of environmental quality. At the national level in those countries where research has been ongoing, and certainly at the international level, something of a plateau has now been reached. Present limiting factors relate to the availability, comparability and reliability of data — until there is a move to gather more data specifically for the purpose of monitoring the state of the environment and societal sustainability, it will be difficult to advance indicator development any further, particularly at the global level. As with adjustments to national accounts, more experience is needed in this field. Once the developers and the potential users of indicators gain such experience, it will help to shed light on the conceptual difficulties and drive the demand for more usable data. It is also important that many stakeholders be involved in the development of indicators. Because indicators communicate a powerful, concentrated message, industry officials, ENGOs and scientists all have a strong interest in ensuring that their particular perspectives are reflected in any set of indicators. What may be a minor conceptual problem to one group is often seen as a major distortion by another.

National environmental plans and policies

Description

Countries are developing and publishing a variety of plans for protecting the environment and resource base. These include *sectoral action plans*, particularly for forestry in tropical countries and for co-operation to protect regions, such as the Sahel in Africa, that cross national boundaries; *environmental, conservation or sustainable development strategies* that are partly based on the World Conservation Strategy and its sectoral management plan for the conservation of living resources; and *comprehensive environmental action plans* focusing on measurable environmental goals and management initiatives with budget allocations to achieve these goals.

Publishing/sponsoring agencies

In the developing world, various agencies have collaborated with national government agencies and with some non-governmental organizations to develop national action plans. In particular, the International Union for Conservation of Nature and Natural Resources (IUCN) has assisted in the development of several dozen conservation strategies in African, Asian and Latin American countries; the World Bank has assisted some nine African countries to develop action plans aimed particularly at protecting natural economic resources. CIDA and other aid agencies have also assisted African countries in this area. The UN Food and Agriculture Organization (FAO) has assisted a number of African countries in developing action plans to combat deforestation and to preserve the economic value of their forest resources. The Permanent Interstate Committee for Drought Control in the Sahel worked with six African countries to develop national action plans that analysed problems and made recommendations for programs to combat drought. Similarly, regional plans have been developed and used for many years — with varying degrees of success — to protect such international bodies of water as the North Sea, the Mediterranean and the Great Lakes. By 1989, 10 years after the publication of the World Conservation Strategy, 54 strategies had been completed or were under way in 41 countries around the world, including both industrialized and developing countries. Least common are detailed national action plans with targets and budgets, noteworthy examples being the Netherlands' 1989 National Environmental Policy Plan and Canada's 1990 Green Plan. Finally, a number of countries publish regular reports for different natural resource sectors that are somewhere between a management plan and an assessment.

Relevance to decision-makers

An action plan that is highly specific in identifying goals and targets is the main reporting vehicle for political accountability regarding initiatives to manage human activities. SOE reports and indicators focus on the environmental results of action plans; however, it is the action plans and strategy documents that are used to hold decision-makers accountable for the accuracy of the analyses, the appropriateness of the targets and the adequacy of the financial commitments. Less specific strategies, although not as useful for accountability purposes, are still helpful in providing a strategic overview and assessment of actions taken.

Discussion

To illustrate, let us look at two examples. Kenya has published a number of reports and studies relating to resource and environmental assessment and planning, including a national SOE report in 1987, two reports on development assistance and natural resource planning, and a 1987 report (sponsored by the World Bank) on the country's forestry sector management. The latter calls for a major redirection of forestry sector management in order to combat threats to agriculture, water and energy supplies, biodiversity and the tourist industry. Its recommendations include protecting at least half a million additional hectares of forest land and establishing woodlots in forest reserves and on farms. The study team recommends a five-year development plan costing US$46 million and states that if these measures are not implemented, the annual cost to Kenya's economy could total more than that of the entire five-year program (Center for International Development and Environment and World Resources Institute, 1990).

It is worth noting that this plan was prepared by an outside agency, something that is not atypical in the developing world. In Kenya, stakeholders in resource policy decisions include not only national government agencies, but also development aid organizations, many non-governmental groups and a citizens' organization specifically involved in energy, forestry, and biomass planning issues (KENGO). In the case of a national plan (the most action-oriented environmental reporting vehicle) the issues of planning for participation and political accountability are as important as the contents of the document, and should be included in the reporting.

A second example is the 1989 National Environmental Policy Plan for the Netherlands (National Environmental Policy Plan, The Netherlands, 1989). This ambitious plan is built around the spatial boundaries (local, regional, river watersheds, continental and global) of various kinds of environmental stress. It uses scenario projections of present states and trends to determine what the implications are for the year 2010. Based on these scenarios, both eventual and interim targets for waste reduction, energy use and other actions are presented. The policy plan takes the position that problems must be solved where they arise — that is, within the same spatial scale — and that environmental problems must not be passed on to the next generation. This responsibility lies with policy decision-makers in all government sectors, as well as with private-sector producers and household consumers. The Netherlands plan is one of the first to seriously address the issue of planning within the constraints of ecological limits. In part, this is because material affluence, and high population density are bringing European countries close to the true limits of their carrying capacity, limits that are increasingly difficult to ignore. The Netherlands plan's multiple-scenario approach — in which all the environmental implications of future development are projected, and trade-offs and goals explicitly considered — seems to bring the implications of inaction into much sharper focus than do most planning and reporting documents.

Environmental assessment (EA) reports and environmental impact assessments (EIA) and statements (EIS)

Description

Environmental assessment is a broader activity than the mandated environmental impact assessment processes that some jurisdictions began to require in the 1970s. The objective of environmental assessment is to predict and evaluate environmental change, particularly that which is caused by anthropogenic agents. In theory, unacceptable change can be anticipated and prevented through modifications to project design, other mitigatory measures or denial of permission to proceed, although the latter is unusual. In the last decade, there have been many calls to expand environmental assessment from its earlier emphasis on projects to include programs and policies. In addition, there have been some applications of environmental assessment to new technologies and products.

Publishing/sponsoring agencies

In countries where EIA is required, administrative agencies are responsible for these activities; often, proponents are required to undertake and publish baseline studies and assessments.

Relevance to decision-makers

With political pressure increasing to widen the application of EA, experiments with generic, regional or class hearings are beginning. In some of these hearings, the scale is so large — for example, in Canada, the federal hearings into the economic development of the Beaufort Sea, or the ongoing generic hearings on forestry and timber management in the large province of Ontario — that, in effect, the decisions made become policy. Testimony and EIS reports in these hearings are often the source of policy-relevant baseline data and projected scenarios similar to national and sectoral action plans. Also, as experience accumulates in the assessment of public policy, environmental constraints on policy will begin to be felt in all sectors. Risk assessment and product assessment also have particular applications in corporate and policy decisions.

Discussion

Environmental assessment, broadly understood, has spurred the development and use of some special tools and applications that are of interest in reviewing the reporting of environmental information. These include *risk assessment* and *product assessment*.

Risk assessment is used to identify environmental risks and estimate their probability. Originating in engineering, it is a technical term with a precise meaning that is used in environmental assessment to compare different kinds of risks in a methodical way (*risk = hazard* X *probability*). Although risk assessment is a conceptually powerful tool, its use in policy decisions is problematic: the fact that the calculation of risk probability iscomplicated usually means the result is not open to scrutiny, and this can make it difficult to defend in the public arena. Moreover, risk assessment ignores important dimensions of risk, particularly the issues of equity, liability and qualitative differences among risks.

Few analysts have confidence in risk assessment as a tool for evaluating absolute risk; nonetheless, it does force risk comparisons to be made in a systematic way. When combined with an economic analysis, it can be a very useful tool for uncovering whether there is a good rationale for the allocation of funds to the reduction of various risks. Policy in the United States has required the use of risk assessment by the Environmental Protection Agency (EPA) to evaluate whether or not regulatory action is warranted with respect to a particular environmental hazard.

Product assessment is a formal process that is used to assess the environmental, and sometimes the social, implications of consumer products. Reports on specific assessments may be the basis for corporate policy decisions about new product lines and production processes. In the public sector, when politicians commit government departments to "green" purchasing policies as part of a national environmental action plan, purchasing must be based on some sort of product assessment. A number of countries, including Germany, Japan and Canada, have product assessment programs for granting a logo to individual product brands to show that certain environmental criteria have been met. Discussions are beginning among the countries that have product assessment programs on ways of recognizing each other's logos. If achieved, agreements in this area could transform already influential national programs into a powerful international trade policy instrument for the development of "environmentally friendly" products.

Environmental audits and corporate environmental reports

Description

Included in this category are annual environmental reports of corporations (a newly emerging form of reporting) and environmental audits prepared by consultants for agencies and corporations.

Publishing/sponsoring agencies

This type of reporting is undertaken by private corporations, and, in the case of audits of government agencies, either the agencies themselves or the Auditor General's office.

Relevance to decision-makers

These audits provide opportunities to clarify internal corporate responsibilities for which the decision-maker may ultimately be responsible, and to ensure that all internal decisions are systematically reviewed with environmental considerations in mind. As well, they provide a reporting mechanism that promotes accountability to shareholders and the public.

Discussion

While environmental audits and reports are still not common in the private sector, they are becoming increasingly so. In the public sector, sectoral audits of environmental performance are not yet part of standard auditing practice, but they are being discussed. The New Zealand government's approach to integrating

environmental policy into other sectoral government departments is through the mechanism of an Environmental Auditor and the reports issued by that official.

Mass print and electronic media

Description

Falling into this category are, primarily, newspapers and television, but also magazines and (in many countries) radio.

Publishing/sponsoring agencies

Environmental reporting in the print and electronic media is undertaken by both the public sector (for publicly owned broadcasting) and private-sector broadcasters and publishers.

Relevance to decision-makers

The print and electronic media are, arguably, the most important source of environmental information for politicians (other than Environment ministers), as well as for senior private-sector decision-makers. Besides providing substantive information on the issues concerned, media attention plays a major role in helping politicians gauge the significance of a problem to various constituencies. This information is critical to decision-makers (see Table 1).

Discussion

With some exceptions, these sources of information tend to focus on issues rather than providing overviews; they are frequently inaccurate, and highlight conflict and human-interest aspects of issues at the expense of proper context and the need for institutional change.

The Future of Policy-related Environmental Reporting

Today, information abounds on specific environmental problems. In shorter supply are reporting vehicles and mechanisms (described in the preceding section) that provide an integrated overview of the environment and human activities, as opposed to reporting on particular issues. This section of the paper summarizes issues already discussed concerning the main vehicles for policy-related environmental reporting, as well as identifying priorities for further action.

For all the reporting mechanisms and vehicles, the issues to be resolved fall into five groups: *user issues*, in particular, identifying the specific users of different reporting vehicles, and whether the information reported is appropriate, given the particular tasks and users involved; *presentation issues*; *normative issues* (i.e., value-laden), relating to the perspective from which information is reported; *conceptual issues*, including which conceptual models and information frameworks are used, and questions about methodological and analytical approaches; and *data issues*, revolving around requirements and deficiencies, and including questions on data availability, reliability, comparability and cost.

State of Environment Reporting

There are important problems with SOE reporting in all five issue categories. This is not surprising, given that it is the most comprehensive form of reporting. The lack of relevant data, particularly in developing countries, is a constraint that needs to be rectified, although it should also be noted that great strides have been made in the global collection of environmental data in the last two decades. There are also important normative issues concerning perspectives in SOE reporting. Little attention has been paid to the spiritual, cultural and aesthetic relationship to the environment felt by many individuals and groups. The characteristically objective, scientific language and approach of SOE reporting does not capture the feelings that many people have towards the landscape or townscape they live in and value, feelings that they want to be reflected in some way in the policy process. However, the keystone problems with SOE reporting are user issues.

User issues as the priority

To date, it is not clear exactly who does SOE reporting, who could use it and which user needs should take priority. Having a range of SOE products can help greatly in this area, since it allows different vehicles to target different audiences. However, even in initiatives as wide-ranging as Canada's SOE programme, there may still be conflicts. For example, there is tension between the needs of analysts, who use the information for in-depth policy reviews and analysis, and the needs of journalists and the general public, for whom SOE reports are educational documents that allow summary judgements to be made about political and national accountability. This divergence of purpose between different user groups affects the structuring of the information. For example, if it is considered that the priority users are journalists and

the general public, then the demand will be for an "issues" focus that enables these audiences to review what action has been taken to address environmental threats they are already aware of. But information on a series of issues is almost beside the point for policy analysts (from all backgrounds and sectors) struggling with the society-economy-environment integration required by sustainable development, particularly if those issues are determined by the attention they receive in the popular press. What analysts need instead is a reporting structure that highlights processes and interactions, with information that sheds light on these more abstract issues. In general, policy analysts interested in sustainable development require an illuminating overview, while journalists and the general public want to know what is happening in their community, on their issues.

Both of these uses for SOE reporting are important in the context of policy decision-making process. Public knowledge and accountability are necessary, but so also is the opportunity for analysts from different sectors to review policy from a more informed perspective and to develop and propose new alternatives. Creative solutions are needed that confront these differences and then address them. New reporting tools and presentation methods may be helpful — for example, the use of scenarios to paint graphic pictures of current trends projected into the future, such as those in the Netherlands' National Environmental Policy Plan. Overlay maps, now made much easier to produce with Geographical Information Systems (GIS) technology, are also especially effective in providing a spatially based overview that conveys highly meaningful information to the general public.

National Accounts

Conceptual Issues as the priority

The three most promising basic approaches and, within each of these three, the soundest methodologies, are quite far from being perfected. Support for the work being led by the UN and others will have to be seen as a long-term commitment, since the technical issues involved are formidable. What is needed in the immediate future is encouragement for the development of statistical bases from which these accounts can be created, particularly in developing countries. Also important is the number of countries and researchers working on such projects and gaining practical experience with different approaches. A range of experience in countries with widely differing economic structures and natural environments will accelerate the process of finding methodological solutions.

Indicators and Indices

With the production of preliminary sets of indicators by the OECD, as well as by certain countries and non-governmental groups, there is considerable interest in this reporting vehicle and some practical experience with it. What further development work is needed?

As with SOE reporting, a strong conceptual framework that answers the question, "What are these indicators *of*?" needs to set the context for families of indicators. Environmental quality indicators addressing biophysical conditions, stresses and trends are one set; however, the relationship between these and sustainable development indicators is not widely understood, nor is it conceptually clear. Simple ecological indicators can address the issue of ecological sustainability; however, the issue of *societal* sustainability requires, in addition, social and economic indicators. There is no consensus on whether the best conceptual approach is to use composite indicators of the several dimensions of sustainability (for example, population health), or separate families of indicators for economic, social and ecological sustainability. Moreover, user needs vary. In particular, there are difficulties between national or sectoral indicators and those that are useful for policy decisions and accountability in an international context. Environmental indicators are almost always constructed from national data; however, since countries differ widely in their approach to data collection, the issue of international comparability arises. It may be that there is a lack of political will at the national level to develop data whose use is driven mainly by international concerns.

Data Issues as the priority

In developing indicators, the most pervasive and difficult problems relate to data. As with SOE reporting, what data are available have traditionally been determined by researchers and others who are collecting data for different purposes. The experience in terms of indicator development in Canada has been that users and analysts can, with some effort, develop a fair degree of agreement on what indicators should be used; always, the stumbling-block is the lack of appropriate data. It may be a lack of time series data, or the scarcity of data in a particular geographical region, or the lack of comparability, or the simple fact that no one has ever needed or collected the information in question. Obviously, an immediate challenge is designing, co-ordinating and establishing new, more appropriate monitoring systems. This will be a difficult process because of costs, especially in less wealthy countries. International co-ordination and

assistance will therefore be needed. Here again, it may be that there is a lack of national political will to develop data collection systems that will be used primarily at the international level.

Better Information Tools for Decision-Making

To conclude this section on new directions, there are a number of concrete steps that might be taken in response to the general problem of transforming and analysing information for policy decision-making.

First, we need to know what information is available. As information and information systems proliferate, there is an increasing need to keep track of the information that already exists; meta-level systems are becoming essential.

Second, the issues of updating and establishing regular reporting systems for environmental information are assuming increasing importance. In the last two decades, managing human activities with environmental objectives in mind has become a major new responsibility for national governments and international agencies. Systematic and regular reporting systems are an essential requirement for such management, and this new need will be a permanent one.

Third, we need more knowledge of what information decision-makers actually use and require, and a better fit between the information tools and the decision-makers' skills and understanding of the issues. In general, environmental reporting has been the domain of scientists; it entered the public arena when environmental action secured a place on the political agenda. Relatively little effort has been devoted to organizing environmental information systems specifically to provide those closely involved in policy decision-making with the information they need, and in the time frame they need it.

Finally, as environmental decision-making becomes increasingly integrated with social and economic decision-making, almost everyone will be personally affected. Moreover, as broad national action plans and international treaties become commonplace, more players will want to have a role in developing the information that forms the basis for proposed action. Without a common understanding of a problem, action to solve it is likely to be contentious and, ultimately, unproductive; in some cases, no action will be possible unless there is general agreement on the knowledge base. Promising directions for the future include multi-stakeholder-directed research aimed at providing a basis for action on specific issues, and the development of political processes aimed at achieving an explicit societal consensus on environmental and other goals.

References

Avérous, Christian P. "Reporting on the State of the Environment: A Review of the Experiences in OECD Countries." Report prepared for the State of the Environment Reporting Workshop, Victoria, Canada, October 24-26 (1989).

Center for International Development and Environment and World Resources Institute. *1990 Directory of Country Environmental Studies*. Washington, DC (1990).

Hamilton, Kirk. Statistics Canada, Ottawa. Personal communication (1991).

National Environmental Policy Plan (NEPP), The Netherlands. *To Choose or to Lose*. Ministry of Housing, Physical Planning and Environment. The Hague: SDU Publishers (1989).

Peskin, Henry M. with Ernest Lutz. *A Survey of Resource and Environmental Accounting in Industrialized Countries*. Environment Working Paper No. 37. World Bank: Washington, DC (1990).

Rapport, David, and Anthony M. Friend. *The Evolution of Information Systems for Sustainable Development*. IREE Occasional Paper Series No. 1. Ottawa: Institute for Research on Environment and Economy, University of Ottawa (1990).

Sheehy, Gregg. *Environmental Indicator Research: A Literature Review for State of the Environment Reporting*. Technical Report No. 7. Hull: State of Environment Reporting Branch, Environment Canada (1989).

World Resources Institute. *Environmental Indicators: A Final Report Summarizing the WRI Review of Indicator Research and Development*. Washington, DC (1990).

Theme Paper Four

Institutional Arrangements and Environmental Information Needs

by

Shuzo Nishioka

and

Yuichi Moriguchi

Center for Global Environmental Research
National Institute for Environmental Studies

Environment Agency, Japan

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Introduction

This paper has been prepared as one of four discussion papers to be presented at the International Forum on Environmental Information. Its purpose is to stimulate discussion at the Forum by providing a general overview of the topic and identifying issues of concern

The paper analyses the institutional arrangements for managing environmental information that are required to be in place for a decision-making process that will foster sustainable development. The focus is on global and international institutional development, and the roles and activities of national and regional governmental, non-governmental, and private organizations working in this area are discussed.

While in past decades there have been considerable efforts to establish useful information bases in the environmental field, many institutional problems remain to be overcome before environmental information can be utilized more efficiently in decision-making, particularly in response to emerging and rapid changes in this field.

Definition and Scope of Institutional Arrangements

Overview

In order to determine the state of the environment, to provide information on it to policy-makers, and to ensure that they respond appropriately, it is necessary to identify the environmental phenomena concerned, monitor them, analyse and compile results, interpret the implications and disseminate the information. A variety of institutions exist to support these functions, including organizations that carry out these activities with legislative and funding support, as well as programmes on which various organizations co-operate, working as part of a wider network. We refer to such systems and their mutual relationships as "institutional arrangements" (Figure 1).

There is often an information department within a national environmental ministry or agency, the responsibilities of which are defined by law. In some cases, a national statistical agency will handle environmental information as one of a number of sets of sectoral information. An information section may form part of a government bureaucracy in some cases, or of a research institute in others. Often, a national centre is also an active participant in international programmes.

Elements of an Institutional Arrangement

Organizations

Organizations can be classified on a geopolitical basis (e.g., national, regional/block, international), a sectoral basis (e.g., environmental, statistical), or a legislative basis (e.g., governmental, non-governmental, private-sector).

Many countries have a national-level environmental ministry or agency. Most of these include a department, centre or division that is responsible for environmental information. In some cases, the national ministry or agency responsible for statistics covers the work on environmental information.

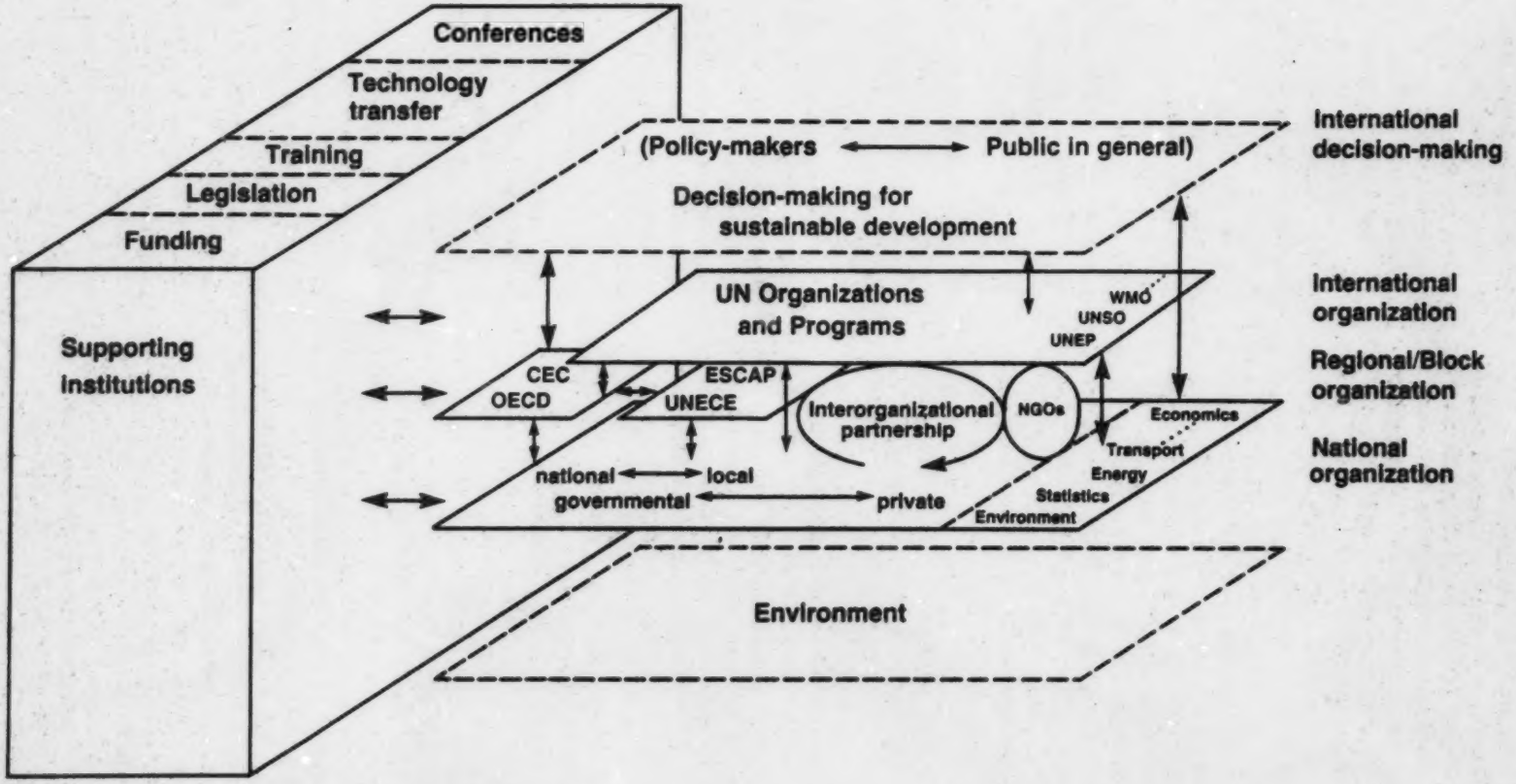
The Organization for Economic Co-operation and Development (OECD) is a typical example of a "block" organization, the common characteristic of its member countries being that they all have market economies. Regional organizations are made up of neighbouring countries, for example, the Association of South-East Asian Nations (ASEAN), the Economic and Social Commission for Asia and the Pacific (ESCAP), and the United Nations Economic Commission for Europe (UNECE). These regional and block organizations share environmental information as a means of resolving common geographical or political problems.

The term "international organization" usually includes regional and block organizations. In this paper, we use the term "international" to mean global or world-wide, with UN organizations being classified as international.

Besides environmental and statistical organizations, other sectoral organizations may play a role in collecting and disseminating environmental information. Included in this group are organizations responsible for sectors of activity that have a direct impact on the environment (e.g., energy, transport, agriculture), organizations responsible for the management of natural resources (e.g., forestry, fisheries) and organizations responsible for human health.

Apart from these national governmental organizations, many other public organizations have important responsibilities related to environmental information. For example, local governments play an essential role in environmental monitoring, and are thus a source of basic information on the state of the environment.

Figure 1. Institutional Arrangements for Environmental Information



Non-governmental organizations, such as non-profit organizations, universities, academic societies, conferences and environmental groups, often play an important part in analysing and disseminating environmental information. Citizens and private companies may also be involved in environmental monitoring. Of course, the latter are also major users of environmental information.

Programmes

It is often difficult to make a clear distinction between programmes and organizations. For example, is the United Nations Environment Programme (UNEP) a programme or an organization? We prefer to define UNEP as an organization, and its related projects, such as the Global Environmental Monitoring System (GEMS), as programmes. The European Monitoring and Evaluation Programme (EMEP) is a typical example of a programme that has no single specific organization serving as a secretariat.

In many cases, an organization (or a group of organizations) will manage its own programme. Even though the programme has its own title, it may bear the name of the parent organization. For example, the OECD's group on the State of the Environment (SOE) has three programmes, namely, System of Information on Resources and the Environment (SIREN), Reporting on the State of the Environment (ROSE), and International Review of Information Systems (IRIS). Their outputs (for example, the State of the Environment report) are recognized as outputs from OECD (or OECD/SOE), as an organization. In this instance, the "programme" can be clearly distinguished as a major work plan of the "organization," which is its vessel.

Legislation

Many activities in the area of environmental information have legislative underpinnings, and the organizations involved in them have their responsibilities and mandates defined by law. For example, national or local legislation on pollution control may define the responsibilities of national government, local government or private companies with respect to pollution monitoring. Without such legislation, it can be difficult to obtain information on pollution on a continuous and regular basis. Legislation may also require that censuses and surveys be conducted periodically (for example, in Japan, the *Nature Conservation Law* requires that the Japanese Green Census be taken every five years).

Countries that take part in international initiatives do not necessarily have legislative backing for these activities. In many cases, they channel their contributions through the national organization that has overall responsibility for the issues concerned. As well, individual national experts often play a significant role in international activities. This can sometimes disrupt the continuity of the work, as their individual-level activities lack national legislative support. For duplication to be avoided and the work to be cost-efficient, it is vital that there be a specific mandate to undertake international activity.

Treaties and conventions aimed at accomplishing clear international goals often require environmental monitoring and periodic reporting to ensure compliance. Activity in the area of environmental information can also be stimulated by the directives and recommendations of international organizations (for example, the Directive by the European Communities on the common environmental quality standard). It can be expected that as more treaties are proposed, and as such agreements become increasingly important to national security, the degree of activity related to environmental information will also increase.

Funding

Funding is also essential to activities in the field of environmental information. In most cases, government budgets form the financial basis of these activities. There are a few exceptions — for example, environmental monitoring by private companies, which is based on the Polluter Pays Principle (PPP), and *ad hoc* activities undertaken by NGOs with assistance from non-profit groups.

Funding is frequently linked to legislation. It is easier to get funding for activities that have legislative backing than to raise funds for new activities that lack a secure organizational and legislative foundation.

Conferences

Recently, a number of conferences on environmental issues have taken place outside the system of regular meetings of established organizations and programmes. Such *ad hoc* meetings can provide a good opportunity for both the production and the dissemination of environmental information. The fact that many experts participate means that new interpretations can be given to existing data, leading to new information. The information exchanged can then be disseminated to concerned parties, including decision-makers, in their respective countries.

The findings of successful conferences can be fed back into existing organizations and their mandates, in the form of statements and recommendations. International conferences of top decision-makers also provide a good opportunity to disseminate information, which must, however, be carefully prepared for this purpose.

The possible deficiencies of such *ad hoc* conferences include lack of continuity and inappropriate role-sharing. Also, discussion may be duplicated if there are many similar meetings.

Other supporting systems

Other institutions that support work on environmental information include training, information exchange, technology transfer and various activities promoting the use of environmental information, especially in developing countries.

Interorganizational Partnerships

The fact that no single organization is capable of fully addressing such a wide field as that of environmental information means that interorganizational partnerships are indispensable to the efficient production and use of such information. These partnerships may be among international, national and local organizations; neighbouring countries; environmental, statistical and other sectoral organizations; measurement, analysis, evaluation and dissemination functions; administration, information, research and development organizations; or finally, among governmental, non-governmental and private organizations.

Information exchange, discussion and co-operative work among organizations from different nations, regions, disciplines and legislative backgrounds have the potential to be fruitful, since all the parties involved share a common policy target or have common issues to be resolved.

Evaluating the Effectiveness of Institutional Arrangements

Overview

A two-dimensional approach can be used to evaluate the effectiveness of institutional arrangements for environmental information. The first dimension is based on the stages involved in producing and disseminating information (i.e., data collection and monitoring, data processing and analysis, and information dissemination), while the second relates to the requirements of those who use the information. Assuming that decision-makers are classified as users, there are three stages to be considered: recognition and identification of issues, evaluation of policy alternatives for responding and decision-making, and implementation and assessment of performance. Environmental information is required at each of these stages, with the type of information needed being somewhat different in each case.

Every institution has its own particular purpose as a producer of information as well as its own target audience (i.e., the users of its products). The purpose and the target audience determine the specific functions of the environmental information and the criteria for evaluating how effectively these functions are supported by institutional arrangements. This section reviews the various functions and requirements of environmental information in order to identify appropriate evaluation criteria.

Functions of Institutions Producing Environmental Information

Data collection and monitoring

The collection of data using various measurement methodologies is the first stage in the flow of environmental information. Without data, no information can be created. Therefore, basic evaluation criteria need to be focused on the *scope* and *quality* of data to be collected.

"Scope" has at least three dimensions: it may be geographical or historical, or it may be related to issues or fields of concern. From an institutional viewpoint, organizations and programmes are usually established either on the basis of geography, or to deal with specific issues of concern. It is all too rare for information to be collected from a historical perspective. At present, there are large imbalances in the geographically based collection of data across the many fields to be monitored, one example being the lack of monitoring stations in developing countries. There are also considerable imbalances among the fields being monitored, so that, for example, the data on surface freshwater are relatively abundant compared to those on groundwater and marine water. There is also a lack of balance among such things as emission inventory, ambient monitoring and the assessment of health and physical effects. On the other hand, the complexities involved when organizations and programmes share functions can result in both duplication and gaps in institutional arrangements. These issues will be discussed further in this paper.

The criteria for evaluating the quality of data include accuracy and comparability, as well as consistency in measurement and continuity of data collection. From an institutional viewpoint, the factors to be evaluated are intercalibration among organizations, standardization of measurement methodology and continuity (ensured by the existence of legislative or financial support). But measurement methodologies are not easily standardized. Individual countries have their own conventions and they may fear that to change these would threaten the consistency of their national data. There is a great need for international collaborative studies aimed at resolving these problems. Moreover, continuity and consistency in data collection depend not only on methodology but also on the human resources involved — periodic personnel changes within organizations can sometimes cause disruptions and lead to inconsistent work.

Data processing and analysis

The extraction of vital information from huge volumes of data is one of the most important tasks related to the use of environmental information. However, it is not easy to get agreement on the criteria to be used in evaluating this function, because the way in which the data are analysed and interpreted depends heavily on the needs of the information users.

If there were some absolute criteria in existence (e.g., pollution standards based on reliable scientific evidence), the task of reporting to decision-makers and the public would be much easier. Moreover, the application of inappropriate criteria undermines efforts to analyse the data further.

If properly applied, such technical tools as tabulation, statistical analysis, graphic data handling, including Geographical Information Systems, may be helpful. Compared to the data-collection and monitoring stage, the data-processing and analysis stage is usually allocated a smaller budget and fewer human resources.

The work at this stage should include not only the processing and analysis of the environmental data themselves, but also their integration with other relevant information. Information users need to know not only *what* is changing in the environment, but also, in order to decide how to respond, *why* it is changing and what effects this is having on the wider environment.

This function of data-processing and analysis should serve as a bridge between the producers of data and the users of information. On the one hand, it should summarize and interpret the implications of the data in an understandable and concise form, and, on the other, it should properly identify the information needs of users so that these can be taken into account at the data-collection and monitoring stage.

Information dissemination

The information-dissemination function serves as an interface between the producers and the users of information. A basic requirement is therefore to provide users with understandable and appropriately analysed data that meet their particular needs.

There are various kinds of dissemination channels for environmental information. They include simultaneous dissemination (e.g., a pollution alert system), an on-line database using a computer network, the publication of reports and statistics, mass communication, education and active access by the public. Growing public awareness of environmental issues indicates the need to strengthen the dissemination function. NGOs such as the World Resources Institute (WRI) and the Worldwatch Institute (WWI) play an important role in disseminating information complete with their own analysis and evaluation.

It is essential that users be targeted with appropriate information, particularly when it is required for decision-making in the areas of policy and investment. The information must also be disseminated quickly and on a regular basis so that issues can be recognized and consequential action taken without delay.

Criteria for Evaluating Institutional Arrangements

Only a few organizations currently undertake the full range of functions, from data collection to data dissemination. However, it is not necessary for every organization to have the capacity to carry out every function. What is more important is for each to have a mandate that clearly sets out its particular function(s).

Figures 2 and 3 illustrate the functions of, and the evaluation criteria for, environmental information, including the supporting institutional arrangements. These are placed in a two-dimensional table showing the stages of data production and the requirements of users, particularly decision-makers. Figure 4 places various organizations and programmes in the same matrix as in Figure 2. These figures suggest how roles may be shared among institutions, how the major function of a particular institution may be adjusted and shifted, and how the producers and users of information can be linked up in

Figure 2. Function of environmental information at each stage of the data production and policy processes.

STAGES OF POLICY PROCESS	STAGES OF DATA PRODUCTION		
	Monitoring and data collection	Processing and analysis	Dissemination
Identification and recognition of issues	Detection of changes in the environment	Transformation to concise information	Education/ Enlightenment
		Identification of cause and effect	
Evaluation and decision-making	Provision of basis for evaluation and decisions	Cost-benefit analysis	Consensus-building
Implementation	Monitoring of policy performance	Evaluation of policy performance	Promotion of public awareness

Figure 3. Criteria for evaluating environmental information at each of the data production and policy processes.

STAGES OF POLICY PROCESS	STAGES OF DATA PRODUCTION		
	Monitoring and data collection	Processing and analysis	Dissemination
Identification and recognition of issues	Accuracy/ Coverage of issues	Understandability of presentation	Quickness
			Periodicity
	Historical and geographical coverage	Understandability of indicator	
Evaluation and decision-making			
	Comparability/ Consistency	Integration with other information	Appropriateness for target user
Implementation	Established methodology	Simplicity/ Measurability	Accessibility to the public

Figure 4. Areas of responsibility and operations of existing institutions at each of the data production and policy processes.

STAGES OF POLICY PROCESS	STAGES OF DATA PRODUCTION		
	Monitoring and data collection	Processing and analysis	Dissemination
Identification and recognition of issues	BAPMoN	Environmental indicator	Statistical compendium
	GEMS/GRID	OECD	SOE reporting
Evaluation and decision-making	EMEP	Natural resources accounting	NGOs (WRI, WWI)
Implementation	GOsOS Alert system	Green GNP	

Figure 5. Functions that need to be strengthened in order to respond to emerging issues.

STAGES OF POLICY PROCESS	STAGES OF DATA PRODUCTION		
	Monitoring and data collection	Processing and analysis	Dissemination
Identification and recognition of issues	Global monitoring and quick reporting	International comparisons	Right to know Privacy
Evaluation and decision-making	Assessment of scientific research results	Integration with other policies Consideration of cost-effectiveness	Intellectual property right International consensus-building
Implementation		Measuring the progress towards sustainable development	

order to make the best possible use of environmental information.

Existing Organizations and Programmes: Review of Activities

Overview

International organizations and programmes

As stated in the section on institutional arrangements, international organizations formed on the basis of geopolitics may be either global or regional/block in character. In this section, we review the UN's activities, including both organizations and programmes. We also review regional activities, including organizations and programmes.

National organizations and programmes

National organizations, such as ministries and agencies, clearly play an essential role in environmental information activities, including those at the international level. It is not within the scope of this paper to review the activities of particular countries at the national level. We merely make reference to the linkages between national and international activities.

Private organizations and NGOs

The activities of NGOs, scientific bodies (such as universities and research institutes) and private organizations are included in the same category as those of national and international governmental organizations and programmes.

UN Organizations

United Nations Environment Programme

If sectoral expertise is used as a basis for classification, the United Nations Environment Programme (UNEP) can be called the "environmental" organization of the UN. UNEP not only produces environmental information through its programmes — for example, the Global Environment Monitoring System (GEMS) — but it also makes decisions on international environmental policy on the basis of information collected and summarized in the UNEP Environmental Data Report (UNEP, 1989). As discussed in the section on *Interorganizational Partnerships*, UNEP undertakes most of its information-producing functions in joint programmes with other sectoral UN organizations.

World Health Organization

The activities of the World Health Organization (WHO) on environmental information pre-date the establishment of UNEP. WHO's survey work on environmental pollution harmful to human health is now integrated into the GEMS programme. WHO also co-ordinates the chemical toxicology information service programme.

World Meteorological Organization

The World Meteorological Organization (WMO), which provides research and monitoring results on the global atmosphere, also has a longer history than UNEP. Its responsibilities include the chemical analysis of atmospheric components as well as monitoring the physical behaviour of the atmosphere. In addition, WMO plays a leading role in research and monitoring in the area of global warming, as evidenced by its sponsorship of the World Climate Conference.

Food and Agriculture Organization

The Food and Agriculture Organization (FAO) is a sectoral organization that deals with agriculture, forestry and fisheries. Its publications include several statistical yearbooks. In particular, FAO's statistics on forest resources are important to the discussion of environmental issues related to forests (e.g., tropical deforestation, carbon cycle). Also, information from FAO on agricultural inputs (e.g., fertilizers and pesticides) is relevant in discussing soil and water pollution.

United Nations Statistical Office

The United Nations Statistical Office (UNSO) is the sectoral organization of the UN in charge of statistics. It provides certain basic socio-economic statistics (e.g., population, energy, industry) on countries the world over. UNSO's recent activities include a methodological study of environmental satellite reports, which will be used to supplement the system of national reports.

United Nations Educational, Scientific, and Cultural Organization

The scope of the United Nations Educational, Scientific and Cultural Organization (UNESCO) is both intersectoral and interdisciplinary. Some of its comprehensive scientific research programmes are relevant to the

environment — for example, its Man and the Biosphere Programme (MAB).

Other UN organizations

Many other sectoral organizations exist within the UN system, some of them with close connections to environmental information. The United Nations Conference on Environment and Development (UNCED) has recently begun working towards the 1992 Brazil meeting. That conference may generate a new direction for environmental policy and, by extension, for environmental information needs, as happened when the World Commission on Environment and Development (WCED) introduced the concept of "sustainable development."

The UN's regional organizations are reviewed in the following section (see *Regional UN organizations*).

Regional/Block Organizations

Overview

As already mentioned, international organizations consisting of a limited number of countries that either share a common socio-economic framework or belong to the same geographical region are categorized as "regional" or "block" organizations. Unlike those of UN organizations, their activities are focused on specific common issues that affect the region or block (e.g., the prevention of transboundary pollution and the adoption of common policy goals). As a result, their activities in the area of environmental information tend to be issue- and policy-oriented, and are often accomplished by concrete policy targets.

Organization for Economic Co-operation and Development

The Organization for Economic Co-operation and Development (OECD) Environment Committee has long played a leading role in the field of environmental information. State of environment reports for OECD countries were published in 1979, 1985 and 1991 (OECD, 1991a), and Environment Data Compendia in 1985, 1987 and 1989 (OECD, 1989). The 1991 state of the environment report was accompanied by a publication on environmental indicators (OECD, 1991b), in response to a directive from the G-7 Summit. Reviews of member countries' environmental policies, as well as numerous issue-specific publications, have also provided information that can be used in making international comparisons.

In addition, the OECD has encouraged member countries to be active in the area of environmental information, in particular, to publish their own state of environment reports and environmental statistics. It has also served as a forum for information exchange. This is reflected in its recently acquired mandate to undertake an international review of information systems, including monitoring (OECD,1988), forecasting, natural resources accounting and information technology.

The OECD's information dissemination strategy provides a good example of a strategy designed to meet policy-makers' needs. At the environmental ministers' meetings, which it organizes about every five years, the OECD routinely tables its state of the environment report. Publishing a comprehensive report of this kind and organizing a top-level meeting at the same time appears to be a most effective and efficient means of providing environmental information to top decision-makers.

Commission of the European Communities

The Commission of the European Communities (CEC) has launched a large number of activities, as CEC member countries not only share a common socio-economic framework but also are located in the same geographical region. Current activities are based on the Coordination of Information in the Environment (CORINE) programme, established in 1985 under the leadership of both Environment Directorate and Statistical Office of the European Communities (EUROSTAT). In 1990, the CEC began publishing Environmental Statistics (EUROSTAT, 1990) on a regular basis.

The activities of the CEC are sometimes more policy-oriented than those of the OECD, since CEC member countries have common policy goals (for example, the environmental quality standards set by directive). CEC's activities in this category include its studies on the international comparability of measurement techniques and network design (CEC, 1986), which were conducted to ensure that the conventional methodology used by each member country is capable of providing internationally comparable data.

Regional UN organizations

There are several regional organizations under the UN, such as the United Nations Economic Commission for Europe (UNECE) and the Economic and Social Commission for Asia and Pacific (ESCAP). UNECE plays a leading role in co-ordinating activities in eastern and western Europe, in collaboration with such regional

organizations as the OECD and the CEC. ESCAP publishes the state of the environment report on Asian and Pacific countries.

International Programmes

Overview

Various international programmes deal with environmental information, some of them being global in scope and others regional. They can be subdivided into two groups — programmes established by a particular international organization (whose mandates, activities and outcomes reflect those of the organization in question), and programmes established jointly by individual countries with support from one or more international organizations. In the former category, the international organization usually assumes responsibility for a substantial part of the work (in both human and financial terms), with contributions from the member countries. In the latter, the international organization(s) take(s) somewhat less of a leadership role. It is to be noted that in both categories, the nature of the work depends largely on the expertise of individual contributing countries, or of specific national-level organizations in the countries that are taking the lead.

UN programmes

GEMS, the UN's key activity in the field of environmental information, acts as a kind of umbrella, with several sub-programmes (e.g., GEMS/GRID (Global Resources Information Database), GEMS/AIR, GEMS/WATER) falling under its aegis. UNEP and other sectoral UN organizations support the GEMS programme. The Global Atmospheric Watch (GAW), which consists of the Background Air Pollution Monitoring Network (BAPMoN) and the Global Ozone Observing System (GO_3OS), is now a programme of WMO. Until recently, BAPMoN came under GEMS, with support from UNEP, WMO and WHO. This kind of programme restructuring becomes necessary from time to time, in order to respond to changing requirements concerning the scope of the information to be covered.

Regional programmes

Regional collaboration is essential to the solution of certain geographically specific environmental issues, namely, acid deposition, marine and international river pollution, the transboundary movement of hazardous wastes, desertification and deforestation, loss of bio-diversity, and so on. EMEP, referred to earlier in this paper, is a good example. About 30 countries from both western and eastern Europe participate in EMEP, forming a network to monitor acid air pollutants and to evaluate the results. EMEP monitoring stations are based on the national monitoring networks of participating countries, and EMEP has no station of its own. UNECE serves as EMEP's administrative secretariat, whereas the program depends heavily on national research institutes in Norway and the USSR for its major technical activities. Also, WMO is committed to EMEP through its BAPMoN programme.

Similar programmes in the field of environmental monitoring include those involving water-quality monitoring of the Baltic Sea and the Rhine, and multi-media monitoring by the Nordic countries.

Non-governmental and Private-sector Organizations

Overview

The role of non-governmental organizations (NGOs) in environmental information has always been regarded as supplementary to that of government organizations. However, some NGOs play a key role in disseminating unofficial (though credible) information in forms that can be understood by decision-makers and the public, thus contributing to a more thorough analysis of the issues. Some NGOs also play a role in environmental advocacy. This can have the effect of over-emphasizing particular issues, and sometimes leads to controversy. NGOs play a major role in the execution of the decisions reached using environmental information, and this will continue to be the case.

Non-profit organizations

Many NGOs are merely passive receivers of environmental information, which they then channel to the decision-makers and the public. But there are also many that are more versatile, using environmental data for policy purposes, to support their advocacy activities. The World Resources Institute (WRI), for example, has played a lead role in establishing international resource accounting systems. For its part, the Climate Institute hosts a series of conferences and seminars to disseminate research results in the area of climatic change.

The roles of NGOs vary considerably by country. For example, in Japan, the dissemination of governmental information depends so heavily on non-profit organizations (as extra-departmental bodies of ministries and agencies) that few NGOs generate their own

independent information. In some developing countries, there are powerful NGOs that serve as major information centres instead of the governments themselves, partly because they have greater flexibility, committed staff and less rigid funding arrangements.

The work of NGOs on environmental information is often institutionally linked to that of governmental and international organizations. For example, the World Resources Report (WRI, 1990) is prepared by the WRI with financial support from UNEP and the United Nations Development Programme (UNDP). Also, with funding from UNEP, the Monitoring Assessment Research Centre (MARC), the WRI, and the United Kingdom Department of the Environment collaborate on the preparation of the UNEP Environment Data Report (UNEP, 1989).

Universities, research organizations and scientific unions

Emerging global environmental issues have strong links to research, which means that universities — not only as educational organizations that use the information, but also as the node of information networks — have an important part to play in integrating information into policy. In response to the need for interdisciplinary collaboration, universities and research organizations are establishing a string of new agencies, usually known as "centres" (for example, the Center for Global Environmental Research (CGER), established in 1990 in Japan).

The main purpose of these centres is to facilitate the exchange of information, both within the academic society and among organizations, and to serve as efficient focal points for information networking. In its International Geosphere and Biosphere Programme (IGBP), the International Council of Scientific Unions (ICSU) — which has initiated many global-scale research programmes — stresses the importance of having a database that can be used by researchers, regional research centres in developing countries and monitoring networks, as well as in developing models for the integration of research results obtained under the programme (IGBP, 1990). Another type of research organization is represented by the International Institute for Applied Systems Analysis (IIASA), which creates various policy tools to assist in decision-making by integrating data into models and by developing data display systems as a communication tool.

The Woods Hole Research Center and the East-West Center host numerous research-oriented conferences for both academics and policy-makers; in so doing, they act as catalysts for the creation of new programmes.

Private-sector organizations

Private industry and business share a role in producing information and providing and reporting data on the emission of pollutants, recycling activity, environmental audits (e.g., the level of their investment in pollution abatement) and so on. Although they have the power to substantially change society, private-sector organizations often do little more than passively receive information. Private-sector organizations can be an essential source of the technical knowledge and information needed to respond to emerging problems (for example, the CFC-ozone layer problem). The role of the media is expanding, not only in disseminating available information, but also in collecting their own data, analysing them and rendering them in understandable visual forms. Private foundations, in their role as programme donors, help to create opportunities for initiating new activities as well as promoting those that are already under way.

Interorganizational Partnerships

Partnerships within UN organizations

As mentioned earlier, GEMS's subprogrammes are implemented by various UN organizations. The UN system is so extensive and each UN organization covers such a limited field that it sometimes makes more sense to separate programmes off from organizations, and to involve many organizations in managing their activities. Another equally rational approach is to restructure the relationship between the organization and the programme, as happened with BAPMoN, GEMS, and WMO. These approaches are also being adopted by programmes at the regional and national levels.

Partnerships in international activities

Partnerships also exist outside the UN system. WMO's collaboration in EMEP is an example of a partnership between a UN organization and a regional activity, while the OECD's collaboration with the CEC is an example of a partnership between regional organizations.

Bilateral and multilateral partnerships

In addition to the collaborative activities of established international and regional organizations and programmes, there are other bilateral and multilateral partnerships that can provide new channels for information exchange and co-operation — for example, development assistance

programmes on region-specific issues, as exemplified in the activities of Japan and the Association of South-East Asian Nations (ASEAN) in monitoring the deforestation of the tropical rainforest using remote sensing.

Intersectoral partnerships within national ministries and agencies

Needless to say, environmental ministries and agencies do not have a monopoly on the production of good national environmental information. In fact, most of the policies that respond to environmental change are implemented by ministries and agencies in other sectors. This means that national ministries and agencies other than those in the environmental sector should play a part in both the collection and the dissemination of environmental information. For example, Japan's emission inventory of air pollutants is jointly compiled by the Environment Agency and the Ministry of International Trade and Industry, and its state of the environment report (the so-called "White Paper") is the subject of thorough interministerial discussions before it goes to publication.

Resources and Technology Supporting Environmental Information Activity

Gap Between Demand and Supply of Human Resources

Human resources in developing countries

In most of the developing world, all aspects of environmental management — environmental information included — suffer from a lack of human and/or financial resources. The GEMS/GRID has had the bitter experience of losing many experts trained under its aegis to industry. There are no easy solutions to this problem. Training remains crucial if reliable data are to be obtained from all over the world. Japan, for example, is stepping up its training efforts by inviting the UNEP Center for Technology Transfer in its Kansai region to begin training activities in 1991.

Need for data handlers to have environmental training

Even in the industrialized world, experts in the field of environmental information come largely from a statistical background, which means that their activities lean too heavily towards the technical and stochastic aspects, sometimes neglecting the goal of efficient and effective information use. Moreover, it is not realistic to expect researchers to continue monitoring after they have used the data for their own research purposes. There needs to be a system for providing data handling experts with appropriate environmental training. Recent efforts by the United Nations University (UNU) to establish a research and training centre on global environment and human health provide an example of an initiative that will increase our ability to acquire globally compatible data sets.

Shortage of Financial Resources

Financial support for developing countries

Recently, the World Bank set up the "Global Environment Facility," a new funding mechanism designed to strengthen the Bank's ability to incorporate environmental considerations into its development projects. Regional assistance organizations such as the Asian Development Bank are following suit, and, in the process, becoming major users of environmental information. The intention is that they will allocate some portion of their funds to information dissemination and to the promotion of co-operative research and monitoring activities.

Some developing countries are receiving bilateral assistance aimed at strengthening their ability to deal with environmental information. For instance, Japan, as part of its overseas development assistance programme, is providing assistance to Thailand for the establishment of a research institute for environmental measurement, to Indonesia for an environmental management centre, and to China for a monitoring network.

Exploiting financial resources for improved collection and processing

The collection of environmental information, particularly on a global scale, requires a broadly diversified system of monitoring points world-wide. This is a very expensive undertaking, especially since it is not possible for all the monitoring points in the system to be managed by one centralized body (as is the case for the Mars Surveyor, in which the resources can be headquartered at one location). Reflecting the system itself, the funds come from diverse sources, with each individual country financing its own project. Moreover, regions not covered by the system need bilateral/multilateral assistance for their activities. To help make the case to the relevant national and international funding organizations, strong recommendations accompanied by concrete action plans must come from information experts in all regions of the world.

Integration of Technological Innovation into Institutional Arrangements

Many technical tools are available for analysing environmental information. Among them is the GIS (Geographical Information System), a continuously evolving tool for standardizing or spatially integrating dependently collected data. The GEMS/GRID programme depends heavily on GIS, and the CORINE also uses it to compile regional mapping information.

Remote sensing, another powerful tool for monitoring the global environment, is capable of breaking through some of the institutional barriers that impede global data collection, particularly in regions where conventional data collection is difficult.

However, we must ensure that our human resources keep pace with our technical capabilities. It is technically possible to produce seemingly realistic information from huge amounts of data that have not been properly analysed by experts. At the same time, technical tools have considerable potential to compensate for shortages in human resources, in that they can assist experts with the work of analysis and interpretation.

Technical innovations in communications, such as the facsimile, microwaves and computer link-ups, have contributed greatly to both the production and the use of environmental information. The use of such tools allows us to exchange printed or digitized data and information in real time, thus avoiding delay in the transmission and receipt of the information needed for decision-making.

Institutional Response to Emerging Issues

Overview

Especially in recent years, our needs in relation to environmental information have been undergoing continual change, and it is important that institutional arrangements should keep pace with these changes. One obvious area affected is that of emerging global and transboundary environmental issues. There are also changes and unsolved problems in traditional issues that require an institutional response. There are many other good reasons for revising our institutional arrangements, including changes in public awareness concerning the environment.

The next two sections will highlight several specific issues and questions — first, those arising as a result of changes in traditional environmental issues and second, those arising as a result of global environmental issues. These issues, together with several general institutional issues already reviewed in the preceding sections, are summarized in Table 1, which will serve as a check-list of the issues for discussion.

Figure 5 illustrates how existing institutions are adapting their operations in order to cope with emerging issues. It also illustrates the gaps that remain to be filled before institutions can become fully responsive.

Institutional Response to Changes in Traditional Issues

Institutional response to regional issues

In recent decades, a number of environmental problems have emerged on a geographical scale that goes beyond the boundaries of any one nation. Such regional issues as the long-range transport of acid air pollutants and pollution of international rivers and regional seas require new institutional responses in terms of environmental information. In many cases, the countries involved in these regional problems are not the same as the member countries of existing organizations. Therefore, the issue at stake is how to establish institutions that are flexible enough to be able to quickly collect data that identify the problem, analyse them, disseminate information for decision-making, and monitor the enforcement and effectiveness of countermeasures taken as a result.

Apart from the question of geographical scale, there may be socio-economic considerations. For example, when the member countries of the European Economic Community integrate their markets, there will certainly be discussion on institutional arrangements, since internationally comparable environmental data will be required as a basis for making decisions and for ensuring compliance with them.

Analysis and interpretation of environmental information for decision-makers

It is often said about environmental information that "the data are rich, but the information is poor" — in other words, we have not yet managed to make the best use of available data. There may be two reasons for this: first,

Table 1
Summary List of Institutional Issues for Discussion

1. General institutional issues: environmental information • Complementary role-sharing between public/private, policy/research, central/local, and environmental/other sectoral organizations • Defined functions for each individual institution as a producer and user of environmental information • Efficient linkage among organizations and programmes • Improved national participation in international activities • Stronger financial and legislative backing • Education, training and other support systems to ensure expanded activity
2. Specific issues: changes in traditional problems areas • Institutional response to regional issues • Analysis and interpretation of environmental information for decision-makers • Improvement of data handling to achieve international comparability • Interrelationships between environmental and other sectoral policies • The right to know and the protection of intellectual property rights
3. Specific issues: global environmental information • Role of information and institutional arrangements in global environmental problems • Need for information from developing countries • Prompt integration and interpretation of global-scale research results and monitoring data • Need to integrate information from other policy fields regarding control of the global environment • Strengthening global environmental monitoring • Information to measure progress made towards sustainable development through policies and programmes

weakness in the work of analysis and interpretation, and second, inadequate scope and quality of data. In any given case, it is necessary to establish which of these is the chief obstacle to the production of information.

Several methodologies have been proposed to facilitate the analysis and interpretation of data. Among the best known tools for aggregating large amounts of data into compact sets of information are environmental indicators, which by definition, are more useful in decision-making than the data themselves. However, two key questions arise, namely: are appropriate data available for calculating indicators? and is there consensus on any given indicator?

If the scope and quality of the data are inadequate for producing information, this fact should be fed back to those involved in data collection and monitoring activities. From an institutional viewpoint, the links between these two stages are vital.

Improvement of data handling to achieve international comparability

Since neither measurement methodologies nor procedures are universally standardized, great caution must be exercised in making international comparisons. Even though measurement methodologies may vary, it is possible to render data more comparable by improving the data handling process, something that will be achieved once the reporting format for key data items is standardized according to the OECD's data-collection questionnaire. Also, the Harmonization of Environmental Measurement (HEM) programme, recently established as part of GEMS, has begun its work of promoting international comparability and compatibility of measurement data (UNEP/HEM,1990).

Interrelationships between environmental policies and those in other sectors

The importance of integrating environmental, macro-economic and other sectoral policies is repeatedly being emphasized. Data are needed not only on changes in environmental phenomena, but also on sectoral development activities related to these changes. This will allow the causes of the changes to be analysed and appropriate responses worked out. In addition, we need to produce and disseminate information on the possible effects of these environmental changes, in order to alert those sectors that may suffer damage as a result.

What this means is that environmental information should be disseminated not only to the environmental decision-makers but also to those in environmentally relevant sectors such as energy, transport, agriculture, health and welfare and general economic policy. Integrated information (e.g., environmental indicators) must be concise and understandable to these users, who are not experts on the environment.

From an institutional viewpoint, establishing a permanent organization to undertake such intersectoral activities would appear to be somewhat difficult. A key issue for discussion is how to find appropriate and flexible institutions (e.g., programmes, conferences) that will allow for major involvement by non-environmental sectors.

The right to know and the protection of intellectual property rights

As the demand for environmental information by various users increases, a key issue at stake is ensuring the accessibility and security of such information. In many countries, there are restrictions on public access to governmental information in general. Access to basic information, including maps, is often restricted for military reasons. As a general rule, only limited governmental environmental information is accessible to the public.

Even when certain information is not restricted, governments are often reluctant to actively provide it to the general public. The activities of NGOs have contributed considerably to the collection and dissemination of non-restricted governmental information. International pressure on governments to open up their information can sometimes change the stance of a conservative national government and persuade it to release more information.

The general rules for the protection of intellectual property rights differ from country to country. For those who collect data and compile sets of information, it can be difficult to distinguish the property rights in the original data from those in the value added through analysis and interpretation. If the property right in the data is too severely protected, this will discourage efforts at analysis, interpretation and dissemination. Legislation in this area should seek to achieve an appropriate balance between the protection of intellectual property rights in the original data and the right to gain access to the data and to utilize them. Indeed, this is one of the areas most urgently in need of appropriate institutional arrangements. The issue of intellectual property rights also surfaces when it comes to transferring technology to developing countries to assist them in achieving sustainable development.

Attention should also be paid to the protection of privacy, in particular for small data samples. Individual industrial and business establishments have a right not to be identified in overly detailed spatial or sectoral disaggregated survey reporting.

Responding to evolving issues

How can we revise existing institutional arrangements to make them more responsive to the ever-evolving issues? Recent efforts at both the national and the international levels may provide us with some alternatives.

The standardization of data collection, analysis and reporting is an example of an emergent issue that has been tackled jointly by the OECD and the CEC in developing a common questionnaire for the collection of data. The next stage is finding out how to extend this initiative to countries outside of these two organizations, and how to involve organizations outside of government, such as NGOs, research institutes and private organizations.

Strengthening policy-oriented activities contributes to the better use of information for decision-making. This is exemplified in efforts to develop environmental indicators.

Working out appropriate roles for the various organizations collaborating on environmental information is another area for attention. Environmental and statistical organizations within government have been taking the lead in conventional environmental information activities, but other sectoral organizations, as well as NGOs, need to be involved in these activities.

Global Environmental Information Issues

Role of information and institutional arrangements

Typically, decisions on global environmental issues have to be taken under uncertain conditions, with lack of information being the key factor. Take global warming, for example. We worry about phenomena that may occur decades from today. Decisions have to be made in the absence of any data on actual change. Bearing in mind the possibly immense costs to the world of their decisions, what data do decision-makers need to be able to reasonably judge a situation and establish an appropriate policy? How can the change be detected? Will the policy harm the economic growth of some countries? The decision-makers must act long before global warming has caused any apparent damage, and they have no other information to go on. Because the phenomenon of global warming is such that its impacts on the global ecosystem may not be reparable for another century, forecasting is necessary to enable decision-makers to act promptly. If future catastrophe is to be prevented, it is crucial to collect data from all over the world and to interpret their implications. It is from this perspective that institutional arrangements should be reviewed, to ascertain whether our reporting system for data world-wide can respond as required, or whether new institutional arrangements are necessary.

Need for information from developing countries

The large geographical area covered by developing countries, the size of their populations and the predicted growth of their activities mean that they have an important role in global environmental issues, both from a physical and a socio-economic standpoint. Without common recognition of the importance of state of the environment reporting, and action to provide objective data, it will be difficult to ensure the participation of developing countries in international collaborative action. At the moment, environmental information on these regions is so scarce that it is vital to fill the gaps in data acquisition.

Rainforests share a large part of the total biomass and are a key factor in rainforest and climate-change issues. Yet the data on rainforest inventory sometimes varies from one source to another. This not only prevents us from fully recognizing the state of environmental destruction, it also hinders us from building international consensus towards co-operative action.

Although efforts to improve the system are continually being made, chiefly by UN organizations, much more institutional effort is required to strengthen the ability of the developing countries to assume their responsibilities in the field of environmental information, especially through such initiatives as joint research programmes and the training of technical experts.

Prompt integration and interpretation of global-scale research results and monitoring data

A particular characteristic of global environmental issues is their close connection to scientific research. The Intergovernmental Panel on Climate Change (IPCC) provides a good illustration of how academics can respond appropriately to urgent requests from policy-makers for state-of-the-art scientific information.

Like scientists themselves, science does not tend naturally towards integration; rather, it tends to break down into

ever more detail. Timely and regular reporting on the assessment of scientific results, and the integration of such results into information that decision-makers and the public can understand are critical to global environmental management. Experts in the information field should address themselves to these issues without delay.

Running parallel to the assessment of research results should be a system for the rapid reporting of globally monitored results, enabling these results to be fed into the forecasting process as early as possible. This would compensate for some of the delays that inevitably characterize international collaborative action.

These kinds of functions should be undertaken by a programme such as the IPCC, in close co-operation with the scientific society. The issue at stake is how to integrate scientific research into public policy, bearing in mind that research-focused monitoring by the scientific society is not necessarily compatible with policy-oriented monitoring.

Need to integrate information from other policy fields

At the Second World Climate Conference (SWCC), a new approach to the design of the Global Climate Observation System (GCOS) was proposed. It emphasized the importance of integrating data related to human activity into conventional climate-monitoring activities (SWCC, 1990). This kind of expansion in our monitoring system is inevitable. Environmental conditions flow from human pressures on nature and vice versa, so it follows that they can and should be managed by controlling human activities.

How much can the rate of global warming be slowed down by restriction on the burning of fossil fuel? What would such a policy cost and what benefits would be derived from adopting a preventive strategy of this type? Is there any way of preserving forests while also securing the economic development of developing countries? How much economic damage will climatic change do to the "bread basket of the world?"

Such questions will go unanswered unless environmental data are gathered with the clear intention of linking them up with data on agriculture and forestry, industrial and urban activity, and with economic data in general. Already, sectoral organizations such as FAO, WHO, and the International Energy Agency (IEA) are recognizing the importance of taking this approach; the next moves must come from the environmental side.

Strengthening global environmental monitoring

Compared to meteorological monitoring, environmental monitoring is less clearly defined and not as highly advanced. This is mainly because of the diversity of items to be measured and the imperfect state of the methodologies to be used. To detect the environmental changes that we are now confronting, a baseline monitoring series must be started immediately. An over-dependence on the introduction of high-tech oriented observing systems would seem to be inappropriate for this purpose; what is required instead is much more widely dispersed *in situ* monitoring. Remote-sensing technology needs to be supplemented by a series of "ground truth" studies, but this calls for a vast investment of human and financial resources. In this context, the activities of GEMS should be strengthened and expanded.

Measuring progress towards sustainable development

While much has been said about sustainable development, very little has been done to formulate the concept to measure the progress of initiatives undertaken in pursuit of it. One exception is the effort to establish new environmental indicators aimed at integrating environmental and economic policies. This theme has been discussed mainly within the OECD, in the wake of a proposal from Canada at the 1989 G-7 Summit. Work is being carried out on natural and environmental accounting systems by such organizations as UNSO, WRI, the OECD and the World Bank (Peskin et al., 1990), and similar trials are being initiated by individual countries, such as France, Norway, Spain, China and Japan. This is another example of efforts to integrate environmental and resources information for policy decision-making, an approach that should be further supported in the future.

The institutional response: current and future

Global environmental issues are forcing the expansion and further specialization of information-related activities. In order to accommodate these requirements at the institutional level, there must be conscious planning towards the revision of existing arrangements, using the evaluation criteria proposed in this paper (which reflect the need to balance reliability with efficiency).

The basic principles for strengthening the information function are as follows:

- **Strengthen the individual components of the current institutional framework rather than introducing a new set of arrangements.**

The history of this field has been too short for all existing organizations to have completed their mandated tasks. Therefore, priority must be given to providing additional resources for these organizations' ongoing activities. Only in this way will policy-makers be able to receive reliable environmental information that has benefited from the expertise of existing organizations. It is also important to secure original data that can be used in the integration of information.

- **Strengthen existing partnerships, programme functions, conferences, panels, etc. as well as working to develop new ones.**

Financial and human resources are too limited to permit the duplication of activities. The promotion of partnerships among existing organizations appears to be the most effective strategy for ensuring that all the issues in this newly emerging field receive appropriate attention. Existing programmes involving governmental participation (e.g., the IPCC) provide an efficient mechanism for carrying out well defined activities within limited resources. In addition, consideration should be given to the development of new partnerships aimed at filling major environmental information gaps in the developing world.

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References

Commission of the European Communities. European Economic Community Directive 80/779/EEC. *A Study of Network Design for Monitoring Suspended Particulates and Sulphur Dioxide in the United States*, Report EUR 10647 EN (1986).

EUROSTAT. *Environmental Statistics 1989* (1990).

International Geosphere and Biosphere Programme. "A Study of Global Change — The Initial Core Projects," *IGBP Report* No. 12 (1990).

Organization for Economic Co-operation and Development. Environmental Monitoring, *Environmental Monographs* No. 16 (1988).

_____. *Environmental Data Compendium 1989* (1989).

_____. *The State of the Environment Report 1991* (1991a).

_____. *Environmental Indicators — A Preliminary Set* (1991b).

Peskin, H. et al. *A Survey of Resources and Environmental Accounting in Industrialized Countries*, World Bank Environment Working Paper No. 37 (1990).

Second World Climate Conference. Conference statement (1990).

United Nations Environment Programme. *Environmental Data Report 1989/1990* (1989).

United Nations Environment Programme/ Harmonization of Environmental Measurement. *A Survey of Environmental Monitoring and Information Management Programmes of International Organizations* (draft) (1990).

World Resources Institute. *World Resources 1990-1991* (1990).

Annex A - List of Acronyms

ASEAN	Association of South-East Asian Nations
BAPMoN	Background Air Pollution Monitoring Network
CEC	Commission of the European Communities
CGER	Center for Global Environmental Research
CORINE	Coordination of Information in the Environment
EMEP	European Monitoring and Evaluation Programme (Co-operative Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe)
ESCAP	Economic and Social Commission for Asia and Pacific
EUROSTAT	Statistical Office of the European Communities
FAO	Food and Agriculture Organization
GAW	Global Atmospheric Watch
GCOS	Global Climate Observation System
GEMS	Global Environmental Monitoring System
GIS	Geographical Information System
GO_3OS	Global Ozone Observing System
GRID	Global Resource Information Database
HEM	Harmonization of Environmental Measurement
ICSU	International Council of Scientific Unions
IEA	International Energy Agency
IGBP	International Geosphere and Biosphere Programme
IIASA	International Institute for Applied Systems Analysis
IPCC	Intergovernmental Panel on Climate Change
IRIS	International Review on Information Systems
MAB	Man and the Biosphere Programme
MARC	Monitoring Assessment Research Center
NGO	Non-governmental Organization
OECD	Organization for Economic Co-operation and Development
ROSE	Reporting on the State of the Environment
PPP	Polluter Pays Principle
SIREN	Systems of Information on Resources and the Environment
SOE	State of the Environment
SWCC	Second World Climate Conference
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNSO	United Nations Statistical Office
UNU	United Nations University
WCED	World Commission on Environment and Development
WHO	World Health Organization
WMO	World Meteorological Organization
WRI	World Resources Institute
WWI	Worldwatch Institute

ANNEX 1

International Steering Committee

Chair

Jean Paul Gourdeau
Le Groupe SNC
Montréal, Quebec, Canada

Members

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Anthony Marcil
World Environment Center
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Paris, France

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Organization for Economic
Co-operation and Development
Paris, France

Michael Gwynne
United Nations Environment Programme
Nairobi, Kenya

Leslie Whitby
Environment Canada
Hull, Quebec, Canada

Forum Secretariat

Paul Rump
Environment Canada
Hull, Quebec, Canada

Annick Le Hénaff
Environment Canada
Hull, Quebec, Canada

Yolaine St-Jacques
Environment Canada
Hull, Quebec, Canada

ANNEX 2

Forum Agenda

MAY 21

1900-2130 **Registration**
Opening Reception

MAY 22

0800-0900 **Registration**
Opening Plenary

0900-0905 **Opening Presentation**
Jean-Paul Gourdeau, Forum Chair
Chairman, Le Groupe SNC

0905-0915 **Opening Address**
Jean Doré
Mayor, City of Montreal

0915-0935 **Ministerial Address**
The Hon. Jean J. Charest
Minister of the Environment, Canada

0935-1020 **Keynote Presentations**
Joseph E. Connor, President
International Chamber of Commerce

Jessica Mathews, Vice-President
World Resources Institute

1040-1150 **Panel on Theme Papers**
Moderator: Dan Tunstall
World Resources Institute

Panel Members
Theme 1: David Pearce
University College, London U.K.

Theme 2: Eric Rodenberg
World Resources Institute

Theme 3: Susan Holtz
Environmental Policy Consultant, Canada

Theme 4: Shuzo Nishioka
Center for Global Environmental Research, Japan

1150-1210 **Workshop Procedure**

1215-1330 **Luncheon**

1330-1630 **Concurrent Workshops**
Theme 1

1630-1800 **Plenary - Theme 1**
Workshop Reports

1830-1930 **Reception**

1930-2130 **Dinner**
Hosted by the Government of Canada
Speaker: M.S. Kismadi, Special Assistant for Foreign Relations Indonesian Ministry for Population and Development

MAY 23

0900-1200 **Concurrent Workshops**
Themes 2, 3 and 4

1200-1330 **Working Luncheon**
Interim Plenary - Themes 2, 3 and 4

1400-1600 **Concurrent Workshops**
Themes 2, 3 and 4

1600-1630 **Statement Preparation Within Workshops**

1630-1800 **Plenary - Themes 2, 3 and 4**
Workshop Reports

1830-1930 **Reception**

1930-2130 **Dinner**
Hosted by; Le Groupe SNC, Alcan, Hydro Quebec and Bell Canada
Speaker: Warren H. Lindner, Executive Director, Centre for Our Common Future

MAY 24

0900-0925 **Closing Plenary**
David Crenna: Presentation of Draft Environmental Information Statement

0925-1140 **Open Discussion and Conclusions**

1140-1200 **Closing Remarks**

ANNEX 3

Listing of Country and Institutional Reports

These reports are available on computer diskette from the Forum Secretariat.

ARGENTINA - Environmental Information for Decision-Making in the Province of Buenos Aires

ARGENTINA - Basic Information to establish a Regional Environmental Diagnosis in Santa Fe Province

ARGENTINE - Information de base pour établir un diagnostic environnemental régional - Situation environnementale de la Province de Santa Fe

AUSTRALIA - Information for Australian Environmental Decisions

AUSTRALIA - Environmental Information Position Paper

BECHTEL - Environmental Information at Bechtel

BÉNIN - Utilisation de l'information relative à l'environnement dans la prise de décision en République du Bénin

BRAZIL - Environmental Information

BRAZIL - Environmental Information for Decision-Making at the University of Sao Paulo

CANADA - The Environmental Power of Telecommunications

CANADA - Environmental Reporting in Canada

CANADA - Les Rapports sur l'état de l'environnement au Canada

CANADA - The St. Lawrence Centre

CANADA - Le Centre Saint-Laurent

CANADA - Steering Committee on Indicators for a Sustainable Society

CANADA - Status Report: Environmental Information and Human Health

CANADA - Status of Environmental Information for Decision-Making at Statistics Canada

CANADA - Status of Environmental Information for Decision-Making: A Youth Perspective

CARIBBEAN DEVELOPMENT BANK - Caribbean Regional Information Systems

CHILE- Status of Environmental Information for Decision-Makers

CHILE- Status of Environmental Information for Decision-Making in CIPMA

COMMISSION DES COMMUNAUTÉS EUROPÉENNES - Mieux connaître notre Environnement pour mieux le gérer - du Programme CORINE

CHINA - Investigation of National Environmental Information System

COSTA RICA - Environmental Information for Decision-Makers in Costa Rica and the Organization for Tropical Studies

CZECHOSLOVAKIA - Information on the Common State Plan for Environmental Protection in Czechoslovakia

UNITED NATIONS ECONOMIC COMMISSION FOR LATIN AMERICA AND THE CARIBBEAN - Summary of the Conceptual Approach of ECLAC Towards Environmental Information

EGYPT - Establishment of an Environment Information and Decision Support System in Egypt

EUROSTAT - Le système d'information statistique européen (SISE) et sa contribution à l'information environnementale

FINLAND - Status of Environmental Information for Decision-Making

GHANA - Status of Environmental Information for Decision-Making

GHANA - Status of Environmental Information for Decision-Making

HUNGARY - Situation and Development Trends of Environmental Informatics

INTER-AMERICAN DEVELOPMENT BANK - Environmental Information for Decision-Making

INTERNATIONAL INSTITUTE FOR SUSTAINABLE DEVELOPMENT - Corporate Reporting

INDIA - Environmental Activities of TERI

INDIA - Environmental Decision-Making

INDIA - Environmental Decision-Making

JAPAN - Environmental Information in Japan

KENYA - State of Environmental Information in Kenya

MADAGASCAR - Utilisation de l'information environnementale dans la prise de décision

MEXICO - Support Infrastructure for Environmental Decision-Making

MEXICO - Environmental Information for Decision-Making

NETHERLANDS - Status of Environmental Information for Decision-Making

NEW ZEALAND - Environmental Information Statement

NORWAY - MISAM - A programme for the Coordination of Environmental and Natural Resource Information in Norway

NORWAY - Environmental Information for Decisions in Norway

ORGANIZATION for ECONOMIC CO-OPERATION and DEVELOPMENT - Environmental Information Systems in the OECD

PÉROU - Situation de l'Environnement

POLAND - Status of Environmental Information for Decision-Making in Poland

POLAND - Environmental Information in the Period of Transition into the Market System

POLAND - General Characteristics of the Ecological Situation in Poland

QUÉBEC - L'information environnementale

SÉNÉGAL - Les besoins des décideurs en matière d'information

SPAIN - Ministry of Public Works and Transportation

SPAIN - Summary of the Status of Environmental Information

TANZANIA - Environmental Information

THAILAND - Environmental Information Public Awareness and Education

TURKEY - Environmental Information in Turkey

UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT - Toward an Information Strategy for Earth Summit '92

UNITED KINGDOM - Environmental Information for Decision-Making

UNITED KINGDOM - Synthesis and Assessment of Environmental Data : The Role of GEMS-MARC

UNITED NATIONS STATISTICAL OFFICE - Brief on the Handbook on Environmental Accounting

UNITED STATES - NCDC Statistics for Monitoring the Environment

UNITED STATES - Status Report on Environmental Information for Decision-making at the U.S. Environmental Protection Agency

THE WORLD BANK - Environmental Information Systems: An Overview of World Bank Perspectives and Initiatives

WORLD CONSERVATION MONITORING CENTRE -Status Report

WORLD HEALTH ORGANIZATION - Environmental Information and Environmental Health

WORLD METEOROLOGICAL ORGANIZATION (WMO) - Global Observation and Environmental Information Programs

WORLD RESOURCES INSTITUTE - Status Report on Environmental Information for Decision-Making

YUGOSLAVIA - Environmental Monitoring Activities of the Hydrometeorlogical Service

YOUGOSLAVIE - L'État de l'information relative à l'environnement pour la prise de décision

ANNEX 4

Delegate List

M. Boualem Fiotemane
Directeur des Échanges Scientifiques et Techniques
Agence Nationale de la Protection de l'Environnement
B.P. 62
EL MARSA BOUMERDES
Algérie

M. Sid Ali Ramdane
Ingenieur agronome
Direction de l'environnement
Ministère de la Recherche et de la Technologie
B.P. 100 - El Madania
ALGER
Algérie

Dr. Abel Fleitas Ortiz de Rozas
Chairman
Interdepartmental Commission for Environmental Policy
Government of the Province of Buenos Aires
Calle 9, No. 1177
CIUDAD DE LA PLATA (1900)
Argentina

Ing. Jorge Alberto Hammerly
Directeur Général
Assainissement de l'environnement et des Affaires écologiques
25 de Mayo 2620, 2e Piso
C.P. 3000
SANTA FE
Argentina

Dr. Roger H. Bradbury
Director
Natural Resource Information Centre
John Curtin House
Brisbane Avenue, GPO Box 858
BARTON, CANBERRA
Australia
ACT 2601

Dr. Barry J. Richardson
Australian National Parks and Wildlife Service
Environmental Resources Information Network (ERIN)
Australian Biological and Environmental Survey
G.P.O. Box 1383
CANBERRA
Australia
ACT 2601

Mr. Graeme R. Oakley
Director
Environment and Natural Resources Statistics Unit
Australian Bureau of Statistics
P.O. Box 10 Belconnen
CANBERRA
Australia
ACT 2616

Mr. Wendell A. Lawrence
Deputy Director - Infrastructure
Caribbean Development Bank
P.O. Box 408, Wildey
ST. MICHAEL
Barbados, W.I.

M. André Dachelet
Chargé de Mission
Cabinet du Ministre de l'environnement de la région wallonne
Square de Meeûs 35 - 4e étage
1040 BRUXELLES
Belgique

Mr. Denis Peter
Programme CORINE
Coordination de l'information sur l'environnement
Commission des Communautés européennes
Bureau 4/246 - Bâtiment Breydel
Rue de la Loi 200
1049 BRUXELLES
Belgique

M. Sylvestre Fandohan
Ingénieur agronome-forestier
Association pour la sauvegarde de l'environnement et le développement
B.P. 06-1269
COTONOU
Bénin

M. Cyriaque H. Gomez
Directeur de l'aménagement du territoire et de l'environnement
Ministère du Plan
B.P. 342
COTONOU
République du Bénin

Mrs. Elisa M. Brandão Cavalcanti
A. Coordinator
National and International Cooperation
Federal Secretariat of Environment
c/o Mr. Paulo de Goes Filho
Diretor do Departamento Técnico Cientifico e de Cooperação
Secretaria do Meio Ambiente da Presidéncia da Republica
BRASILIA
Brasil

Dr. Carlos Celso Do Amaral E Silva
Universidade de Sao Paulo
Facuidade de Saude Publica
Departamento de Saude Ambiental
Av. Dr. Arnaldo, 715
SAO PAULO, 01255
Brazil

Dr. Diogenes Salas Alves
Associate Researcher
National Institute for Space Research (INPE)
C.P. 515 - CEP 12201
SAO JOSE DOS CAMPOS
Brazil

Dr. Ian K. Crain
Associate Professor
Faculty of Engineering
Dept. of Surveying Engineering
University of Calgary
2500 University Drive N.W.
CALGARY, Alberta
Canada
T2N 1N4

Mr. John Lilley
President
Canadian Society of Environmental Biologists (CSEB)
c/o 1003 Garland Terrace
SHERWOOD PARK, Alberta
Canada
T8A 2R5

Mr. Stephan Barg
Treasurer
International Institute for Sustainable Development (IISD)
212 McDermot Avenue
WINNIPEG, Manitoba
Canada
R3B 0S3

Ms. Susan Holtz
Research Consultant
Energy, Resource and Environmental Policies
Box 49, Site 15, R.R.#5
ARMDALE, Nova Scotia
Canada
B3L 4J5

Mr. Richard Kenno
Principal Environmental Consultant
Safety, Health and Environment
ICI Canada Inc.
90 Sheppard Avenue East
Box 200, Station A
NORTH YORK, Ontario
Canada
M2N 6H2

Mr. Kirk Hamilton
Manager
National Accounts and Analytical Services Field
Statistics Canada
R.H. Coats Building, 26th Floor
Holland Ave. and Scott St.
Tunney's Pasture
OTTAWA, Ontario
Canada
K1A 0T6

Ms. Janice M. Hopkins
Executive Director
Health Protection Branch
Health & Welfare Canada
Room 115, Health Protection Building
Tunney's Pasture
OTTAWA, Ontario
Canada
K1A 0L2

Mr. Maldwyn Thomas
Executive Director
Canadian Secretariat ICC/BIAC
c/o Gowling, Strathy & Henderson
Suite 2600 - 160 Elgin Street
OTTAWA, Ontario
Canada
K1N 8S3

Mr. James P. Bruce
Chair
Canadian Climate Board
World Meteorological Organization (WMO)
1875 Juno Avenue
Ottawa, Ontario
Canada

Mr. Michael A. Neuman
President and CEO
Mediatel Inc.
1 Nicholas Street, Suite 1500
OTTAWA, Ontario
Canada
K1N 7B7

Mr. Joe Thwaites
National Coordinator
Canadian Student Pugwash
902-151 Slater Street
OTTAWA, Ontario
Canada
K1P 5H3

Dr. Leslie Whitby
Director General
Interpretation, Communication and Co-ordination
State of the Environment Reporting
Environment Canada
Place Vincent Massey, 11th Floor
351 St. Joseph Boulevard
HULL (Québec)
Canada
K1A 0H3

Mr. Jim D. Collinson
Assistant Deputy Minister
State of the Environment Reporting
Environment Canada
Place Vincent Massey, 11th Floor
351 St. Joseph Blvd.
Hull (Québec)
Canada
K1A 0H3

Dr. Rouchdy Saleh
Program Officer
CIDA
200 Promenade du Portage
HULL (Québec)
Canada
K1A 0G4

Mr. Ian H. MacLachlan
Vice-President
Bechtel Québec Ltée
620, boulevard René Lévesque
Suite 1270
MONTRÉAL (Québec)
Canada
H3B 1N7

Mr. Kevin G. Dobby
Regional Director
International Air Transport Association - IATA
2000 Peel
MONTRÉAL (Québec)
Canada
H3A 2R4

Mme Hélène Gauthier Roy
Chef de service
Planification et relations gouvernementales
Vice-présidence, Environnement
Hydro-Québec
1010, rue Sainte-Catherine est (6e étage)
MONTRÉAL (Québec)
Canada
H2L 2G3

M. Pierre-Marc Johnson
Bureau d'avocat Guy et Gilbert
770, rue Sherbrooke ouest
Bureau 2300
MONTRÉAL (Québec)
Canada
H3A 1G1

M. H. Guy Rochon
Vice-Président
Affaires internationales
Photosur Géomat (PGI)
5160 Décarie, Suite 300
MONTRÉAL (Québec)
Canada
H3X 2H9

M. Peter Jacobs
Professeur titulaire
Université de Montréal
Faculté de l'aménagement
École d'architecture de paysage
Pavillon 5620 Darlington, Local 3016
C.P. 6128, Succursale A
MONTRÉAL (Québec)
Canada
H3C 3J7

M. Yvon Charbonneau
Vice-Président
Relations extérieures, environnement
Le Groupe SNC
2, place Félix-Martin
MONTRÉAL (Québec)
Canada
H2Z 1Z3

M. Jean-Paul Gourdeau
Chef du Conseil
Le Groupe SNC
2, Place Félix-Martin
MONTRÉAL (Québec)
Canada
H2Z 1Z3

M. Michel P. Lamontagne
Directeur exécutif
Centre Saint-Laurent
Conservation et Protection
105 rue McGill, 4e étage
MONTRÉAL (Québec)
Canada
H2Y 2E7

M. Pierre Gosselin
Médecin-Conseil
Département de Santé Communautaire
Hôpital de l'Enfant Jésus
1401, 18e rue
QUÉBEC (Québec)
Canada
G1J 1Z4M.

M. Paul Meunier
Chef du Service État de l'environnement
Ministère de l'Environnement
Gouvernement du Québec
2360, chemin Sainte-Foy - 1er étage
SAINTE-FOY (Québec)
Canada
G1V 4H2

Mr. Juan Domingo Molina Valenzuela
Head
Agriculture Management
(Universidad Catolica de Chili)
Comision Nacional del Medio Ambiente (CONAMA)
Alameda Libertador Bdo.
O'Higgins No. 280
SANTIAGO
Chile

Mr. Emile Dopheide
Officer, ECLAC/UNCHS
Environment and Human Settlements Division
Economic Commission for Latin America and the
Caribbean - United Nations
Casilla 179-D
SANTIAGO
Chile

Ms. María Teresa Lladser
Coordinator of Information and Documentation
Centro de Investigación y Planificación del Medio
Ambiente (CIPMA)
Juan Crisóstomo Jaques 2268
Providencia
SANTIAGO
Chile

Mr. ZhenYuan Xu
Senior Engineer
Head, Information Division
Institute of Environmental Management
Chinese Research Academy of Environmental Sciences
100012 ANWAI BEIYUAN
BEIJING
Peoples Republic of China

Mr. Alexander Bonilla Duran
Asesor Ambiental del Ministro
Ministerio de Recursos Naturales, Energia y Minas
Apartado Postal 6732-1000
SAN JOSÉ
Costa Rica

Mr. Jose Maria Rodriguez
Environmental Policy Coordinator
Organization for Tropical Studies (OTS)
Apartado Postal 676-2050
SAN PEDRO MONTES DE OCA
Costa Rica

Mr. Cheikh Sarr
Directeur
Département de l'agriculture et du développement rural
Banque africaine de développement
B.P. 316
ABIDJAN
Côte d'Ivoire

Ing. Jozef Brezak
Deputy Director
Federal Committee for the Environment
Slezska' 9
120 29 PRAHA 2
Czech and Slovak Federative Republic

Mr. Hisham El Sherif
Advisor to Minister of Cabinet Affairs & Minister of State for Admin.
The Cabinet, Information Decision Support Center (IDSC)
11A, Hassan Sabry Street, Zamalek
CAIRO
Egypt

Dr. Hany Shalaby
Director
EXCOMP - Petroleum Exploration Computer and Consulting Services - Egypt Branch
Street 263 Corner 280
New Maadi
CAIRO
Egypt

Ms. Effat El Shooky
Director
International Cooperation of Egyptian Cabinet
The Cabinet, Information Decision Support Center (IDSC)
11A, Hassan Sabry Street, Zamalek
CAIRO
Egypt

Mr. Mohammed H. El Boreini
The Cabinet
Information Decision Support Center (IDSC)
11, A. Hassan Sabry Street
Zamalek, CAIRO
Egypt

Mr. Heikki Sisula
Chief Inspector
Environmental Protection Department
Ministry of Environment
Ratakatu 3
P.O. Box 399
SF - 0012 HELSINKI
Finland

Mr. R. Heikki Salmi
Head of Department
Central Statistical Office of Finland
P.O. Box 504
SF - 00101 HELSINKI
Finland

Mr. Paul Schreyer
Organisation for Economic Co-operation and Development
2, rue André-Pascal
75775 PARIS CEDEX 16
France

M. Christian Avérous
Administrateur
Direction de l'environnement
Organisation pour la coopération et le développement économiques
2, rue André-Pascal
75775 PARIS CEDEX 16
France

Mr. Nigel Blackburn
Directeur
Chambre internationale de commerce
38, cours Albert Premier
75008 PARIS
France

Mr. Kwame Oheneba Omari
Programme Officer
Environmental Protection Council
P.O. Box M-326
ACCRA
Ghana, West Africa

Mrs. Edith Hazel
Deputy General Secretary
31st December Women's Movement
P.O. Box 065
ACCRA
Ghana, West Africa

Dr. Miklós Bulla
Head, Environment Analysis Department
Ministry for Environment and Regional Policy
1011 Fó u. 48-50
BUDAPEST
Hungary

Mr. János Vargha
President
ISTER, East European Environmental Research
Váci utca 62-64
BUDAPEST 1056
FSZT 5, Hungary

Mr. Pál Sebestyén
Head of Department
Ministry of Environment and Regional Policy
P.O. Box 351
1394 BUDAPEST
Hungary

Dr. Ramnik H. Parekh
Group Medical Advisor
Unilever Group - India
Hindustan Lever Limited
165/166 Backbay Reclamation
BOMBAY
400020
India

Prof. Manohar Singh Rathore
Senior Fellow
Institute of Development Studies, Jaipur
B-124, Mangal Marg, Bapu Nagar
JAIPUR - 302 015
Rajasthan
India

Dr. R.K. Pachauri
Director
Tata Energy Research Institute
7 Jor Bagh
NEW DELHI
110003
India

Mr. M.S. Kismadi
Special Assistant for Foreign Relations
State Ministry for Population and Environment
Jl. Medan Merdeka Barat 15
JAKARTA
Indonesia

Dr. Allan Kirton
Permanent Secretary
Development and Planning
Jamaican Ministry of Finance
11A Oxford Road
KINGSTON 5
Jamaica

Mr. Yuichi Moriguchi
Research Official
Center for Global Environmental Research
National Institute for Environmental Studies
16-2, Onogawa
Tsukuba
IBARAKI 305
Japan

Dr. Shuzo Nishioka
Director
Center for Global Environmental Research
National Institute for Environmental Studies
Environment Agency of Japan
16-2, Onogawa
Tsukuba
IBARAKI 305
Japan

Mr. Reuben V. Mugo
Acting Director
National Environment Secretariat
P.O. Box 67839
NAIROBI
Kenya

Mme Gertrud Hilf
Chef de Division
Commission des Communautés européennes/Eurostat
Bâtiment Jean Monnet
Kirchberg
L-2920 LUXEMBOURG
Luxembourg

M. Victor Rabary
Directeur Général
Office national de l'environnement (ONE)
IG 161 A. Ambalavao-Isotry
ANTANANARIVO 101
Madagascar

M. Rolland Ramahatra
Vice-Président, Conseil d'administration
Association nationale d'actions environnementales
(ANAE)
IB 52, rue de Belgique
TANANARIVE 101
Madagascar

Mr. Luis Manuel Guerra Garduño
Director
Instituto Autonomo de Investigaciones Ecologicas, A.C.
Castellanos Quinto 87
Colonia Centinela
C.P. 04450
MEXICO CITY,
D.F.
Mexico

Mr. Jorge Pezzat Villegas
Licenciado en Economia
Director de Programacion y Evaluacion
Direccion General de Planeacion
Secretaria de Desarrollo Urbano y Ecologia (SEDUE)
Vincente Eguia Numero 46, 7 Piso
Colonia San Miguel, ZP 11850
Chapultepec, MEXICO CITY,
D.F.
Mexico

Dr. Hernando Guerrero Cazares
Director de Instrumentacion y Sistemas
Comision Nacional de Ecologia
Rio Elba Numero 20
Piso 14, Colonia Cuauhtemos
MEXICO CITY,
D.F.
Mexico 06500

Dr. A. Adriaanse
Ministry of Housing,
Physical Planning and Environment
P.O. Box 450
2260 MB LEIDSCHENDAM
The Netherlands

Mr. Eddy Goldberg
Research Co-ordinator
Environmental Policy Directorate
Ministry for the Environment
P.O. Box 10-362
WELLINGTON
New Zealand

Dr. Sam Olanrewaju Talabi
Chairman and Consultant Director
Talon (Nig.) Ltd.
12-14 Aerodrome Road
P.M.B. 1303
Apapa, LAGOS
Nigeria

Mr. Erik Lykke
The Fridtjof Nansen Institute
P.O. Box 326
N-1324 LYSAKER
Norway

Mr. Sergio Kostritsky Pereira
Directeur pour l'environnement
Ministère des relations extérieures du Pérou
Jiron Azangaro 450
LIMA 1
Peru

Dr. Antonio Brack-Egg
Scientific Advisor
Associacion Amazonia
Bolognesi 159
LIMA 18
Peru

Ms. Jolanta Szczerbinska
Specialist
International Cooperation
The Central Statistical Office, Poland
Al. Niepodleglosci 208
00-925 WARSAW
Poland

Mr. Marian Grzesiak
Deputy-Director
Agriculture, Forestry and Environment Protection
Division
The Central Statistical Office, Poland
Al. Niepodleglosci 208
00-925 WARSAW
Poland

Mr. Józef Jablonski
Science Secretary
Institute of Environmental Protection
Ul. Krucza 5/11
00-548 WARSAW
Poland

Mr. Andrzej Czyz
Deputy Director
Department of International Cooperation
Ministry of Environmental Protection, Natural Resources and Forestry
52/54 Wawelska Street
00-922 WARSAW
Poland

M. Cherif Mbodj
Directeur Général
Organisation Informatique Gestion (OIG)
5, Avenue Georges Pompidou
B.P. 21451
DAKAR
Sénégal

M. Mamadou Diop
Directeur technique
Société africaine de raffinage
B.P. 203
DAKAR
Sénégal

Sr. José Muro de Zaro
Arquitecto - Subdirector General de Coordinación e Información
Secretaria General de Medio Ambiente
Paseo de la Castellana No. 67
MADRID, 28071
Spain

Sr. Francisco Tapia
Subdirector General de Calidad Ambiental
Secretaria General de Medio Ambiente
Paseo de la Castellana No. 67
MADRID, 28071
Spain

Dr. Arno Rosmarin
Information Officer
Stockholm Environment Institute
Box 2142
S-10314 STOCKHOLM
Sweden

Mr. Janos Pasztor
Senior Officer
United Nations Conference on Environment and Development (UNCED)
160 Route de Florissant
P.O. Box 80
CH-1231 CONCHES
Switzerland

Mr. Warren H. Lindner
Executive Director
The Centre For Our Common Future
52, rue des Pâquis
1201 GENEVA
Switzerland

Dr. Venance W.K. Fupi
Chief Government Chemist
Government Chemical Laboratory
P.O. Box 164
DAR ES SALAAM
Tanzania

Mr. Godfrey L. Kamukala
Director General
National Environment Management Council
P.O. Box 63154
DAR ES SALAAM
Tanzania

Dr. Suvit Vibulsresth
Deputy Secretary-General
The National Research Council of Thailand
196 Phahonyothin Road
BANGKOK 10900
Thailand

Mr. Weera Sakultab
Director
Information and Environmental Quality Promotion Division
Office of the National Environment Board
60/1 SOI Phibun Watthana 7 Rama VI Rd.
Phayathai
BANGKOK 10400
Thailand

Mr. Engin Ural
Secretary General
Environmental Problems Foundation of Turkey (EPFT)
Kennedy Caddesi 33/3
06660 Kavakdlidere
ANKARA
Turkey

Mr. Tom Karl
Chief, Global Climate Laboratory
National Climatic Data Center
National Oceanographic and Atmospheric Administration (NOAA)
Federal Building
ASHEVILLE,
North Carolina 28801
U.S.A.

Mr. Peter Bartelmus
Chief
Environment Statistics Section
United Nations Statistical Organization
NEW YORK,
N.Y. 10017
U.S.A.

Ms. Anna Theofilopoulou
TNC Affairs Officer
United Nations Centre on Transnational Corporations (UNCTC)
2 U.N. Plaza, DC2-1274
NEW YORK,
N.Y. 10017
U.S.A.

Mr. Joseph E. Connor
Chairman
Price Waterhouse World Firm
1285 Avenue of the Americas
NEW YORK,
N.Y. 10019
U.S.A.

Mr. Glenn Morgan
Environment Specialist
Resource Surveys & Monitoring
Environment Department
World Bank - Room 55107
1818 H Street, N.W.
WASHINGTON,
D.C. 20433
U.S.A.

Mr. Peter H. Freeman
Environmental Assessment Specialist
Environmental Protection Division
Inter-American Development Bank
1300 New York Avenue, N.W.
Stop E0809
WASHINGTON,
D.C. 20057
U.S.A.

Dr. N. Phillip Ross
Director
Center for Environmental Statistics Development Staff
U.S. Environmental Protection Agency
Rm. 3313 CY (PM-223)
401 M Street, S.W.
WASHINGTON,
DC 20460
U.S.A.

Mr. Andrew Parker
World Bank
Presidential Plaza
900 - 19th Street
4th Floor
WASHINGTON,
D.C. 20006
U.S.A.

Ms. Jill Johnson
Economist
Assistant to the Canadian Executive Director
World Bank
1818 H Street, N.W., Rm 01321
WASHINGTON,
D.C. 20433
U.S.A.

Mr. Eric Rodenburg
Research Director
World Resources Report
World Resources Institute
1709 New York Avenue, N.W., 7th Floor
WASHINGTON,
D.C. 20006
U.S.A.

Mr. James C. Morant
Center for Environmental Statistics
Development Staff
U.S. Environmental Protection Agency
401 M Street, S.W. (PM-223)
WASHINGTON,
D.C. 20460
U.S.A.

Dr. Jessica Mathews
Vice-President
World Resources Institute
1709 New York Avenue, N.W.
Suite 700
WASHINGTON,
D.C. 20006
U.S.A.

Ms. Ingrid Schulze
Health Statistician, P.M. 223
Office of Policy, Planning & Evaluation
U.S. Environmental Protection Agency
401 M Street, S.W.
WASHINGTON,
D.C. 20460
U.S.A.

Mr. Daniel B. Tunstall
Senior Associate
World Resources Institute
1709 New York Avenue, N.W., Suite 700
WASHINGTON,
D.C. 20006
U.S.A.

Mr. Richard J. Olson
Adviser on Environmental Data and Trends
Council on Environmental Quality
722 Jackson Place, N.W.
WASHINGTON,
D.C. 20503
U.S.A.

Mr. John McComb
Manager, Biodiversity Information
World Conservation Monitoring Centre
219 Huntingdom Road
CAMBRIDGE CB3 0DL
United Kingdom

Ms. Ann Willcocks
Research Scientist
Monitoring Assessment Research Centre (MARC)
King's College London
University of London
The Old Coach House
Campden Hill
LONDON, W8 7AD
United Kingdom

Mr. David Pearce
Department of Economics
University College London
Gower Street
LONDON,
WCI E6BT
United Kingdom

Mr. Mladomir Jovasevic
Counsellor
Federal Hydrometeorological
Institute
Bircaninova 6, P.O. Box 604
BELGRADE
Yugoslavia

Dr. Vesna Vladikovic
Senior Adviser
Environmental Section
Federal Section for Development
Omladinskih Brigada 1
NOVI BELGRADE
Yugoslavia